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FITTING ROLLER BEARING ON WORM SHAFT OF SCREW DOWN GEAR FOR STRIP MILL

The Iron and Steel Foundries Regulations 1953

The problem of the jobbing foundry

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Leading Article
Teaching Physics 1

Principal Articles
Marine Turbine Research 7
The Iron and Steel Institute in Sweden : Treatment of Iron-Ore Fines 8
Steel on the Defensive 10
British Electrical Power Convention : Electrical Engineering in World Trade 11
Electric Lighting Developments 12
Electricity in the Home 12
Rural Electrification 13
Coal Utilisation Research 14
The National Institute of Agricultural Engineering 14
Electric Locomotives 16
Making Laminated Plastics 18
Fluid Valve with Mechanically-Rotated Plug 19
The Woodhead New Tunnel 20
Transporting and Delivering Material in Bulk 23
Dry-Type Air-Cooled Transformers 24
Automatic Control for Machine Tools 25
Remote-Controlled Marshalling Gear for Railway Wagons 26
Tanker Heating Coils of Aluminium Alloy 28
Protection Against Stalling 29
Diesel Engine Power Pack 29
New Carbonising Plant at Stockton 30

Weekly Survey
Import of United States Machinery 2
Changing Pattern of Soviet Industry 2
International Technical Assistance 2
Searching for Natural Gas in Britain 3
Diesel Rail-Cars 3
Progress in Steel De-Nationalisation 3
Factory Building Expansion 3

Letters to the Editor
"Packaged" Boilers 5

Obituary
Dr. Karl T. Compton 5

Personal 6

Business Changes 6

Launches and Trial Trips 7

Book Reviews
Increased Thermal Efficiency of Solid Fuel through Gasification 9
Questions and Answers on Power Station Practice and Plant 9
Questions and Answers on Distribution and Use of Electric Power 9
Electrical Installation Work 9

Books Received 9

Trade Publications 9

Labour Notes 32

Notices of Meetings 32

News
Institution of Civil Engineers Conversazione 4
Electrical Accidents in Mines 6
Instruments and Printing Exhibitions in 1955 6
Maleic Anhydride: New Plant to be Constructed 8
Quality of Carburising Atmospheres 13
Electricity Supply in May 18
One Year Course in Concrete Practice 22
Research Assistantships 22
Insulating Fishplates 24
The Television Centre 29

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TEACHING PHYSICS

THE unprecedented need for technologists in numbers that overcrowded our universities for some years after the war now shows signs of abatement in a few directions. In the case of physicists, however, the demand for trained workers remains insistent and tends, if anything, to increase as the result of the expansion of Government research in nuclear physics and developments in electronics and its applications. Practically every physics graduate, as soon as he is qualified, can obtain employment either in a Government establishment or in industry, where the value of physicists is now widely recognised. Apart from monetary reward, such a post offers the attractions of a progressive career, opportunities for putting newly acquired knowledge of physics to immediate practical use, and incentives to keep abreast of the advance of science.

These are some of the reasons for the present shortage of physics teachers, more especially school-masters, to which Professor R. Whiddington, C.B.E., F.R.S., directed attention in his presidential address to the Physical Society last month. Of the physicists now passing through our universities, a few have the brilliant mind and the sense of vocation that will make them outstanding figures of their generation. A few others have the gift or the liking for teaching that will lead them to be school-masters regardless of the sacrifice entailed. The majority are apt to look on teaching as a livelihood rather than a career, many of those who give the matter a second thought being deterred by the need to undergo a course of specialist training in school teaching. These constitute the bulk of the nation's physicists and their numbers are so disproportionally large compared with those entering the teaching profession that the future supply is, in Professor Whiddington's opinion, seriously threatened.

He pointed out that, if the present trend continues, the average schoolboy coming up to the university to read physics must have a lower standard of elementary knowledge at a time when university lecture standards are continuously rising to correspond with the expansion of physics. The reduction to three years of the time spent at a university over a qualifying course in physics has been possible only because the ground of the old, introductory, first university year was adequately covered by a sufficiency of good science masters during the last year at school.

Professor Whiddington's view of this situation is confirmed by a recent report on "Graduate Teachers of Mathematics and Science," issued by the National Advisory Council on the Training and Supply of Teachers; and he is no doubt justified in holding that swifter action is desirable, to counteract the shortage of graduate school-masters, than the long-term effects envisaged by the Council would seem to require. The remedial suggestions he makes are therefore worth careful and critical consideration since they themselves raise fresh problems for which easy solutions are not obvious. This is certainly true of his submission that the status of the school-master must be raised by every means, presumably to attract more graduate entrants against competition from Government establishments and industry. It is not easy to see how, or why, teachers of physics can be preferred over their colleagues teaching non-scientific subjects. The same applies to the suggestion that physics masters should be induced to continue at work well beyond the normal retiring age, and Professor Whiddington admits that, at best, this would be only a temporary palliative.

There is much more to be said for the idea of facilitating the transfer to teaching of the proportion of highly qualified men in industrial or Government employment who find themselves less suited to investigatory work than they once thought they were, and would welcome the change if it did not entail too much financial sacrifice. Similarly, no doubt, some professional physicists would willingly undertake part-time coaching. The fact that technologists in considerable numbers regularly take evening classes in technical schools is a clear indication that part-time teaching can produce excellent results. It is by no means so clear, however, that part-time coaching in day schools would commend itself to employers of a small research staff, or conduce to the efficient prosecution of either research or teaching except it were conceived on a generous and far-sighted scale. Unless, for instance, the school is close to the physicist, there must be wastage in travelling time, and inequality of opportunity due to the mere geographical distribution of schools.

Notwithstanding the difficulties inherent in the Professor's suggestions they provide a basis for further study on a national scale. The use, as senior school-masters, of research physicists after normal retirement is, for instance, an extension of his present suggestions that might repay examination. With more promise, the contribution to be made by technical colleges in the way of physics teachers working part-time in schools, or school classes being taught, during day or evening, at technical colleges, warrants full exploration.

Weekly Survey

IMPORT OF UNITED STATES MACHINERY

Since the war, there have been many complaints about the restrictions on imports into the United Kingdom of machinery from the United States. Manufacturers, unable to obtain comparable machinery here, have resented as short-sighted a policy which they believe to have seriously hampered them in expanding exports. The announcement last week that these restrictions are to be relaxed will therefore be very welcome.

Although the severe shortage of dollars since the war has forced the Government to keep imports from the United States at a minimum, they have never made the mistake of completely banning machinery. Fully-fashioned hosiery machines, earth-moving equipment, civil airliners, machine tools and office machinery are but a few examples of engineering products which have been imported in volume from the United States. The licensing authorities in these instances have been satisfied that there was a clear balance of economic advantage to justify the dollar expenditure. The recent announcement brings no radical change of policy; the Board of Trade have still to be satisfied that the dollar machine to be imported will reduce costs, and that no alternative non-dollar machine offering roughly the same advantages is available. The improvement in the Sterling Area gold and dollar reserves should, however, enable them to be more sympathetic to applications.

In some cases, manufacturers and the Board of Trade have been in serious disagreement about the advantages to be got from American machinery. The Government, anxious to encourage the manufacture of comparable machinery at home, have naturally restricted licences when British machinery – or atl east machinery made in Britain – has come on the market. This policy has encouraged manufacturers from the United States to make earthmoving equipment, office machinery, etc., in the United Kingdom or to grant manufacturing licences to British companies. Such equipment has, of course, been comparable in all respects with that made in the United States, and British buyers have only been too glad to be able to purchase it at home. In some cases, however, British manufacturers have had to undertake the basic design and development of machinery of the types formerly imported. Users who have been accustomed to American-built machines are often difficult to convince that the British machinery can be as good, and, in some cases, they have been confirmed in this belief by the eething troubles which have developed in the new British equipment. The Government have, therefore, been pressed from time to time to allow more, say, hosiery machines or heavy tractors to be imported; unless it becomes clear that the British equipment is never likely to be as satisfactory as the American, the Government would, of course, be unwise to succumb to this pressure.

This does not mean that they must accede to a policy of economic nationalism. No country can be self-supporting in all types of machinery, and it is not desirable that it should be. The Government recognised this when they ordered machine tools for the re-armament programme to the value of £11 millions in the United States. Some of these, perhaps, could have been obtained in the United Kingdom; but, even so, there was a net balance of advantage in having these made in the United States, for it enabled British manufacturers to keep up their export effort and, indeed, some took the opportunity to establish themselves in the United States market while the United States manufacturers were preoccupied with their own re-armament programme.

The total amount of machinery now being imported is not large in relation to total imports from the United States. In 1953, it was only £39·5 millions compared with a total of £634·4 millions, and it was £7·6 millions less than in 1952. There thus seems little cause for the Board of Trade to be too unbending when it is possible to make a case at all for importing American machines.

* * *

CHANGING PATTERN OF SOVIET INDUSTRY

Information received in this country recently suggests that Russian industry is expanding at a considerable rate, but in a direction rather different from that of previous years. The Soviet Government's promise to increase output of consumer goods at a higher rate than had been envisaged in the 1951–55 plan has created an urgent need for machines, the production of which has not been expanded on the scale required. From this doubtless stems the large import demand for textile machinery and machine tools for light-and medium-engineering production. The difficulty of training labour is forcing Russian engineers to rely more and more on special-purpose machines and automatic controls. Automatic and semi-automatic machine tools, which in 1939 represented only about 5 per cent. of the total output of the Russian machine tool industry, are now reported to account for more than half the total. Details have recently been published in this country (*Financial Times*, June 22), of a fully automatic motor-car piston factory where all manufacturing processes, as well as inspection and handling, are said to be " fully automatic and performed without interruption and without direct participation of manual labour." This could not have been achieved without a full range of electronic instruments, and suggests that Russian industry in this field compares with that elsewhere. The Soviet Academy of Science has a special Institute for Automatics and Telemechanics, which is reported to be designing fully-automatic factories and has been instructed to determine priorities in the introduction of automatically-controlled special-purpose machine tools in Soviet industry.

Such developments were forced upon Soviet engineers by the decision to improve on the annual growth of 11 per cent. in the output rate of consumer goods. It should not be supposed, however, that this decision will be allowed to interfere with the planned rate of capital investment, which was fixed at 13 per cent. per annum for the 1951-55 plan.

The search for higher productivity in Russian industry through specially designed machines and automatic controls may, if successful, vitally affect the world balance of economic power. There are unlikely to be many difficulties concerning standardisation and long-production runs in an economy where the range of designs offered to the consumer is probably more restricted than anywhere else in the world.

* * *

INTERNATIONAL TECHNICAL ASSISTANCE

The Expanded Programme of Technical Assistance has been described by a representative of a participating nation as " in many ways a model of what an ideal United Nations Programme should be." In scale, it does not compare with many major development schemes, but it should yield a return out of all proportion to the outlay. It aims not at providing material assistance in the form of plant machinery and equipment, but at promoting international exchange of technical knowledge; hence it costs little more than the salaries and living expenses of the experts made available to advise on specific economic, administrative, or technical problems to the countries which require them. Fellowships for the technical training of nationals of underdeveloped countries in more advanced countries are, of course, also provided; but the total programme in 1953 cost only 23·5 million dols. – much less than the Technical Assistance Board would have liked to provide and nearly 60 per cent. less than would have been required to meet the heavy volume of requests from Governments.

Expenditure in 1954 has unfortunately had to be restricted further to 22·2 million dols. Even so it will be possible to provide technical assistance to 76 countries and territories, involving a total of 1,974 experts and 1,762 fellowships, and, as the Technical Assistance Board point out in their recent report (Technical Assistance Committee, Sixth Report of the Technical Assistance Board, published by the United Nations on June 24, 1954) the programme has actually benefited in some ways from the restraints which have had to be exercised. Financial management has improved, and more effective use is being made of the sums allocated due to the co-operation of recipient Governments who have taken greater care in reviewing priorities and in co-ordinating their own claims for assistance. This attempt " to work out comprehensive technical assistance programmes at country level " was, according to the report, perhaps the most significant development in 1953.

The range of the programme is necessarily restricted through inability to provide large missions and plentiful equipment, but this perforce ensures that it is closely moulded into the existing pattern and that the assistance " will not be too far divorced from the existing level of the technique and development." It is not related directly to any source of capital supply, but this means that it will not neglect the vast field which it has to exploit in improving the use of capital resources and facilities.

Eight of the principal agencies in the United Nations Organisation participate in the programme. The Food and Agriculture Organisation has the greatest share of the total expenditure (26 per cent. in 1953), followed by the U.N. Technical Assistance Administration (24 per cent.), the World Health Organisation (20 per cent), United Nations Educational Scientific and Cultural Organisation (13 per cent.), the International Labour Organisation (11 per cent.) Such assistance can thus be provided to cover every aspect of a country's economic and social life. India, for example, is receiving technical assistance from all the agencies which are mentioned above. UNTAA are providing experts on statistical quality control, on plastic mouldings, scientific instruments and the marketing of handicrafts. Three technical advisers were provided for the fertiliser plant at Sindri, and two chemical engineers for the penicillin factory at Pimpri. ILO experts advised on social security, productivity and the training of supervisors. Arrangements are now being made for the establishment of an Indian National Productivity Centre. F.A.O. advised on crops, livestock, nutrition and also upon the maintenance of agricultural machinery and the training of operators. Other countries, for example, Libya and Burma, were advised on public administration and finance.

Inevitably, the large underdeveloped countries were the principal recipients of assistance. The Indian programme costing nearly 1 million dols. will be the largest in 1954, followed by those for Pakistan (nearly 900,000 dols.) and Iran (nearly 800,000 dols.). The underdeveloped countries,

however, also had something to give; 53 Indian experts and 24 Mexican served in other countries. The benefits of the Assistance Programme lie by no means solely with the recipients. By promoting international co-operation in raising the general level of technology and living standards in the world, the Technical Assistance Board is providing a most effective stimulus to the trade of the more advanced countries.

* * *

SEARCHING FOR NATURAL GAS IN BRITAIN

In an attempt to counteract the rising price of fuel and the increasing scarcity of good carbonising coals, the Gas Council began a search six months ago for supplies of natural gas in Sussex, Yorkshire and Lincolnshire, as part of a five years exploration plan; more sites in other counties in the south of England and in the midlands are to be surveyed in the near future. The Sussex site is in Ashdown Forest, near Crowborough, where drilling by the D'Arcy Exploration Company has been in progress for about five weeks. Using an 87-ft. rig of the type familiar in oil-drilling operations, a depth of about 850 ft. had been driven by last week into the Purbeck limestone, a geological structure of shale and shell limestone.

During the progress of this work cores of rock brought up in a 20-ft. drill tube have been tested for porosity in a mobile laboratory on the site, and some gas, samples of which have been sent away for analysis, has already been discovered. It is not expected, however, that any great volume of gas, which does not occur in pockets but fills the pores in the rock, will be released until a depth of some 2,000 ft. has been reached in three or four months' time; and several other bore holes will have to be driven before the total volume in the field can be assessed.

It is interesting to record that it has been known for many years that supplies of natural gas exist in this part of Sussex – often quite near the surface. In fact, the railway station at Heathfield has been lighted by this means for many years and there has been a " burning bog " at Hammerden. The results of this new investigation will therefore be awaited with interest, especially in view of the effects that the discovery of natural gas is having upon the national economy of the United States, Canada and the north of Italy. At its best it will provide a much needed new source of fuel and, even if not successful, is a tribute to the enterprise of an important British industry.

* * *

DIESEL RAIL-CARS

It has long been recognised that Diesel traction offers substantial economies in many operations, and British Railways have been severely criticised for their slowness in introducing it. This criticism has not been entirely justified. Conditions for Diesel operation in the United Kingdom are not quite so favourable as those in, say, the United States, where steam locomotives have almost ceased to be built; moreover, the amount of capital investment which British Railways have been permitted to undertake since the war has been seriously restricted. The relatively high initial cost of Diesel locomotives has undoubtedly been a serious drawback from the British point of view. The five-year programme announced last year of providing 573 Diesel shunting locomotives is probably as much as can be undertaken in the present financial state of the railways; but at this rate, it will take a long time to displace all the steam shunting locomotives in use.

The use of Diesel power for secondary passenger services has now been very extensively explored by British Railways, who for many months operated experimental services with a lightweight Diesel rail-car train unit in various parts of the country. On the first operational services begun in the West Riding of Yorkshire on June 14, eight two-car units are scheduled to cover 522,000 train miles a year compared with the present 309,200 steam miles; operating costs are expected to be cut by £8,000 a year; and, through the attraction of additional traffic, it is hoped to improve the financial results by a further £22,000 a year.

The extension of such services to all areas could mean very large economies. The present programme, which will cost £2 millions, is to extend them to West Cumberland, to Lincolnshire and to the Newcastle-Middlesbrough and Edinburgh-Glasgow runs. The thirteen units being built for West Cumberland at the Derby works of British Railways will be available in the autumn and thirteen more for Lincolnshire will follow later from the same works. The Edinburgh-Glasgow units will incorporate rather greater amenities and will afford a prototype for fast inter-city Diesel services.

It is obviously desirable that British Railways should push ahead as far as possible with these developments, which appear a solution to one of their oldest, most serious problems – road competition. They will also assist such manufacturers of heavy commercial vehicles as Leyland Motors and Associated Commercial Vehicles, who supply the 125-h.p. engines and have formed a joint subsidiary for the manufacture of rail-cars. Diesel traction is, however, by no means the only claimant for the capital resources of British Railways. Another offering substantial economies is electrification, and some further progress in this direction was made recently when services started on stage two of the Wath-Sheffield-Manchester electrification scheme.

* * *

PROGRESS IN STEEL DE-NATIONALISATION

By the beginning of last month, the Holding and Realisation Agency had marketed about 13 per cent. of the book value of the securities in steel companies taken over from the Iron and Steel Corporation. Since then the share capital of the English Steel Corporation and of Stewarts and Lloyds have been put on the market and, though several of the large steel concerns have still to be de-nationalised, the pattern of ownership is already beginning to take shape. In recent weeks Vickers, Limited and Cammell Laird and Company, Limited, have jointly re-purchased the share capital of English Steel Corporation, and Arthur Lee and Sons, Limited, have re-purchased Arthur Lee and Sons (Hot Rolling Mills) and Arthur Lee and Sons (Cold Strip). In May, it was announced that Guest, Keen and Nettlefolds, Limited, were buying back most of its former steel assets. This has been a complicated transaction because it has involved the company purchasing all the shares of G. K. Baldwins Iron and Steel Company, including the minority interest in that concern formerly held by Richard Thomas and Baldwins. The shares in United Steel Companies and Lancashire Steel Corporation have already been sold to the public. In March, half the capital of Darlington and Simpson Rolling Mills was sold back to its pre-nationalised owner, Crittall Manufacturing Company, Limited, the other half still remaining with the, as yet, nationalised Dorman Long and Company. Templeborough Rolling Mills is now owned, to the extent of one-third each, by British Ropes, Limited, William Cooke and Company, Limited and United Steel Companies, Limited, an arrangement which is not dissimilar to the pattern of ownership which existed before nationalisation. Round Oak Steel Works has been sold to Tube Investments, Limited, Sheffield Forge and Rolling Mills to Darwins, Limited, The District Iron and Steel Company, to J. Brockhouse and Company, Limited, and the Hallamshire Steel and File Company to James Neill and Company (Sheffield), Limited.

It is apparent that the de-nationalisation of the steel industry is being accompanied by a good deal of integration among the steel companies, and between steel and engineering concerns. Some of the largest steel companies have still to be marketed, but it already looks as though the organisation of the industry will not be dissimilar to the one which existed before the experiment in nationalisation took place. It would be unwise, however, to reach any firm conclusions about the effect of the new integration of the steel companies in the light of the pre-nationalised pattern of the industry. While it is true that integration among companies would favour some concerns in the event of a steel shortage, it is much too early to generalise about the effect of the new groupings on the steel-industry's efficiency and policy as a whole.

* * *

FACTORY BUILDING EXPANSION

There is every indication that expansion in factory building will go ahead rapidly this year unless building costs continue to rise. An interim report of the National Federation of Building Trades Employers pointed out last month that costs are now the limiting factor.

In the first quarter of this year 524 factory-building projects, with an area of 10·7 million square feet, were authorised compared with 373 projects with an area of 7·1 million square feet in the same quarter of 1953. The same trend is apparent if building-development figures are looked at in a slightly different way. In the first five months of this year, there have been 169 applications in the Midlands area for industrial-development certificates with an area of 2·9 million square feet compared with 110 with an area of 1·9 million square feet in the first five months of last year. This pressure for increased investment in factory building is accompanied by a housing target of 340,000 dwellings. The pressure on the demand side is, therefore, likely to be sustained unless some sections of the industry are adversely affected by further cuts in defence expenditure and the trend for householders to carry out their own repairs continues to expand. There has, in fact, been increased competition in the last twelve months for medium-sized construction work. Supplies of building materials continue to improve, but the report of the Building Trades Employers, mentioned above, clearly showed concern lest increased rail charges and higher wages have a serious adverse effect on building-material prices. If they do, there is some possibility that the recent strong upward movement in building licences granted will peter out.

The scope which exists for reducing building costs is displayed at the Building Plant Exhibition which opened at Reading last week. Greater progress has been made with mechanisation than some of the critics of the building industry are prepared to concede, but there are further opportunities for reducing costs by using mechanical equipment now that building materials are in freer supply and there is no danger in the near future of under-employment of labour in the industry.

INSTITUTION OF CIVIL ENGINEERS CONVERSAZIONE

APPARATUS AND CONSTRUCTION SCHEMES

Civil, marine and hydraulic engineering, building methods, the use of instruments in engineering work, and road safety were among the subjects represented in a display of models, apparatus and equipment, assembled in the library of the Institution of Civil Engineers on the occasion of their annual conversazione, held this year on Thursday, June 24. The exhibits of immediate civil-engineering interest included a method of studying the behaviour of arch dams experimentally by means of rubber models, a collection of instruments for measuring displacements in engineering structures and a model of London Airport showing the first stage in a development programme. Other models illustrated the use of pre-cast pre-stressed concrete deck units in bridge building, the prevention of coastal erosion and the suppression of waves entering the cooling-water outlet flume of a power station. There were in addition models of an Admiralty oiling jetty, a heel-trunnion bascule bridge and various construction schemes.

Among the exhibits of a more general nature were: portable instruments for detecting flaws in railway lines ultrasonically, a hydrographic sounding unit designed to record the interval between the emission and return of sound waves reflected from the sea bed, a flow analyser for pipeline systems and an extrusion gun for repointing brickwork. Also displayed were models representing a pulverised-fuel boiler, a method of raising coal through pipes from the pit bottom to the surface by circulating water and a mechanism for handling deep-sea repeaters during the laying of ocean cables.

Certain of the exhibits are described here.

THE LAYING OF TRANS-OCEAN CABLES WITH RIGID REPEATERS

When submarine cable is employed for telephone purposes it is necessary to include at intervals of approximately 50 miles delicate electronic units known as repeaters, and to provide a means of laying cables equipped in this way the Hartley-Ashby repeatered-cable laying gear has been devised. The repeater, which serves to maintain the strength and purity of high-frequency signals, is, in the two-way form employed by this country, contained in a heavy steel cylinder 11 ft. long and 1 ft. in diameter. The cylinder is rigid but must nevertheless be carefully handled; in particular, the junction between repeater and cable must not be subjected to bending.

During laying, the cable may undergo a pull of nearly 15 tons and to restrain its movement over the stern of the ship a braked cable drum was formerly used. With the introduction of repeatered cables this practice becomes impossible and instead the Hartley-Ashby gear employs two restraining mechanisms in series, which the repeater passes in turn.

As the repeater emerges from the cable hold the forward mechanism is open to allow it to pass. During its journey from the forward to the aft mechanism, the repeater operates two contact switches, one of which automatically closes the unit already traversed and another which opens the aft mechanism, which is shown in the left-hand illustration. The cable is thus freed successively by the two units but is always restrained by one of them.

Restraint is imposed in each case by a pair of V-grooved pulleys to which a given braking torque can be applied. The pairs of pulleys are carried on pivoted arms which can be rotated in the vertical plane of the cable to give the cable-free and cable-gripped positions. In the free position, the two pulleys are located one above the other and are sufficiently clear of the cable for the repeater to pass between them; recesses in the ship's deck accommodate the lower pulley of each pair. When the appropriate switch is operated the pulleys swing in complementary arcs and apply a double bend to the cable, thus making it secure.

The repeaters travel in ducting which is slotted to permit the action of the securing gear, and are launched by means of a swinging cradle, shown in the right-hand illustration. Pulleys at either end of the cradle protect the cable-repeater joint from any bending moment and the repeater undergoes a smooth and continuous passage from the cable hold to the sea bed.

The gear has been designed by A. C. Hartley, C.B.E., M.I.C.E., and R. J. Ashby, A.M.I.C.E., in collaboration with Johnson and Phillips Limited, Charlton, London, S.E.7, and the Telegraph Construction and Maintenance Company, Limited, 22 Old Broad-street, London, E.C.2, and a model of it was demonstrated at the conversazione.

OILING JETTY AND DAM ANALYSIS

Of both marine and civil engineering interest were two models of the Admiralty oiling jetty at Devonport Dockyard; one depicted the head of the jetty and the other, representing the approach and including a floating pile-fixing gauge, showed the mooring layout and the construction methods employed.

As indicated in the model, the approach to the jetty was constructed from 14-in. by 14-in. pre-stressed concrete piles capped with pre-cast concrete beams and deck slabs. All the piles were driven and all the pre-cast units were placed from floating craft and construction proceeded at a rate of 760 ft. in 42 days.

The head of the jetty, which was supported on 60 Larssen B.P.4 box piles, consisted of a concrete slab ranging in thickness from 3 ft. 6 in. to 2 ft. 6 in. and cast in position. As in the approach, pile driving and the mixing and placing of concrete were performed entirely from floating craft and therefore neither false work nor temporary piles were necessary. Also shown in the exhibit were models of the 50-ft. long shuttering units employed, which could be moved along the steel traverse beams and wedged in each concreting position. Four 43-ton suspended fenders, one of which was represented in the model, were used in the construction; these were slung from six suspension units, each of which included a rubber spring.

The model was exhibited by Mr. A. E. Chatterton, B.A., B.A.I., A.M.I.C.E.

The use of rubber models in an experimental study of an arch dam was demonstrated in an exhibit presented by Mr. G. M. Binnie, M.A., M.I.C.E., and Professor A. J. S. Pippard, M.B.E., D.Sc., M.I.C.E., F.R.S., of the Imperial College of Science and Technology. Four structural models cast solid in rubber by Rubber Developments, Limited, Welwyn Garden City, Hertfordshire were shown and these represented: a symmetrical dam in a vertical sided valley, a symmetrical dam in a V-shaped valley and preliminary and final designs for Dokan dam. Dokan dam is a concrete arch dam, 380 ft. high above lowest foundation level and 1,150 ft. in crest length, which is now under construction on the Zab River in Iraq.

The models were subjected to water pressure and the displacements measured. The results provided time-saving data for relaxation computations and also afforded valuable control on this and other similar methods of stress analysis.

COAST EROSION

Diagrams, photographs and models exhibited by Mr. J. Duvivier, B.Sc.(Eng.), M.I.C.E., illustrated certain aspects of beach stabilisation and the protection of coastal land against erosion and flooding. One model represented an articulated concrete groyne specially designed for exceptional conditions arising from its prominent position at the point of Selsey Bill. The groyne embodies mass and stability but is nevertheless sufficiently flexible to allow differential settlement to occur without damage to the structure.

A second model illustrated an intermediate stage in the stabilisation of a beach having little or no littoral drift. In this case groynes retain the small quantity of shingle and coarse sand resulting from the erosion of the underlying strata which consist mainly of fine sand, silt and clay. The groynes are designed to be made in sheet-steel piling in order that they may be re-driven to suit the changing profile of the beach. Diagrams were displayed to show the effect of wind and fetch on littoral drift and the construction and protection of a sea wall by stages.

KWINANA REFINERY

Under construction on the coast of Western Australia, 12 miles from Fremantle, for Australasian Petroleum Refinery, Limited, an associate of the Anglo-Iranian Oil Company, is the Kwinana Refinery. A port, eventually able to accommodate simultaneously three tankers of 32,000 tons, is also being built. The refinery, which is to be commissioned early in 1955, will have an output of 3 million tons a year and will cost £30 million. It will operate on Middle East crude oil and will send products by sea to New Zealand and to the eastern states of Australia. The main design contractors for the refinery, a perspective model of which was shown at the conversazione, are the M. W. Kellogg Company, and their subsidiary, the Kellogg International Corporation.

The model displayed at the conversazione indicated the extent of the refinery, which

Trans-ocean telephone cables fitted with 11-ft. rigid repeaters can be layed with equipment represented by this working model. The first illustration shows one of the two restraining units which secure the cable in turn as the repeater passes the other; the second shows the repeater launching cradle.

covers 900 acres, and showed the jetty under construction in Cockburn Sound.

HYDRAULIC TRANSPORT OF COAL

The British Hydromechanics Research Association has been investigating the problems associated with the hydraulic transport of solids with particular reference to its use in collieries, and a transparent working model of a unit for lifting coal from the pit bottom to the surface was demonstrated at the conversazione. The model was capable of raising through a 1-in. pipe one ton of coal an hour, but a full-scale installation with a 12-in. pipe could deal with several tons of 4-in. coal each hour.

Among the advantages of such a system is a reduction in the quantity of dust generated and hence in the risk of fire, explosions and lung diseases. Moreover, the system is continuous in operation and consequently more efficient than normal methods, especially in pits where output is restricted by the limited capacity of the shafts and winding gear.

The model included a reciprocating feeding mechanism by means of which coal is fed into a high-pressure water supply line, thus dispensing with the need for a high-pressure pump capable of dealing with coal. A unit for raising coal hydraulically has been installed and recently completed at Woodend Colliery, Scotland.

PIPE-FLOW ANALYSER AND DISPLACEMENT INDICATORS

To simplify calculations concerning hydraulic flow in pipe-line networks, an analyser has been devised and was exhibited at the conversazione by Mr. T. M. Prus-Chacinski, A.M.I.C.E. The analyser is based on the analogy between electric current and liquid flow and comprises a number of non-linear electrical resistor sets, each representing one branch of a network.

The resistors are constructed in such a way that their voltage-current characteristic corresponds to the relationship between head and rate of flow in pipes, as expressed in the Hazen-Williams formula.

The Building Research Station of the Department of Scientific and Industrial Research displayed a number of indicators used to measure displacements in structures. Among the instruments shown were a vibrating-wire gauge for assessing changes in the diameter of a submerged tunnel by means of frequency measurements and a ring deflectometer incorporating an electrical strain gauge. Also exhibited was a displacement indicator made by Saunders-Roe, Limited, Osborne, East Cowes, Isle of Wight. This instrument employs an inductive pick-off which is a form of electro-mechanical transducer and has been designed especially for use with the indicator to measure small mechanical movements.

REPOINTING BRICKWORK

A method for repointing brickwork at high speed by means of an extrusion gun has been developed by the Western Region of British Railways and the equipment required and an example of brickwork repointed in this way was exhibited at the conversazione by Mr. G. R. Smith, M.B.E., B.Sc., M.I.C.E.

Essentially the method is to propel foamed mortar through a gun into previously cleaned joints and its application is important where, for example, the density of rail traffic permits only brief periods of operation. The joints are cleaned by high-pressure jets of water containing a small proportion of detergent.

The foamed mortar is prepared in a vortex mixer and placed in pressure pots from which it is brought by compressed air through hosing to the guns. The pressure in the pots is so regulated that the flow of foamed mortar through the stem of the gun is approximately 0·0005 cusecs. In addition a supply of auxiliary air enters the foamed-mortar stream just before it emerges from the nozzle. It is claimed that with one gun rates of pointing of 25 to 30 square yards an hour can be maintained for long periods.

Letters to the Editor

"PACKAGED" BOILERS

British Builders

SIR, In your issue of April 2 you described (page 441 of your previous volume) a packaged boiler for steam raising or water heating, and on page 418 you stated that " in Britain a boiler of this type has not previously been available." We would like to correct this impression, since we are supplying such boilers, and in fact have orders on hand for several units at the present time.

The boilers we supply are a development of a design originated by our American associates, Foster Wheeler Corporation. We supply them for capacities from 1,500 to 30,000 lb. per hour at design pressures of 250, 525 and 825 lb. per square inch. Boilers up to 15,000 lb. per hour are assembled at our works, and above this capacity they are assembled at site.

Yours faithfully,
FOSTER WHEELER, LIMITED,
J. ARMAN.

3 Ixworth-place,
London, S.W.3.

[G. W. B. Furnaces, Limited, whose boilers were described in the article in question, have replied that, in view of this letter, it is surprising that the productivity team reported " There is need (in Britain) for the development of a type of self-contained automatically-controlled oil-fired boiler of the American packaged pattern to supply the heat requirements of commercial buildings and small industrial plants." Their claim is that they make a range of such boilers from 500 to 17,250 lb. per hour, steam or hot water, and suitable for firing by oil, gas or a combination of oil and gas.—ED., E.]

* * *

OBITUARY

DR. KARL T. COMPTON, C.B.E.

It is with deep regret that we record the death, last week, of Dr. Karl T. Compton, chairman of the Massachusetts Institute of Technology and, for many years, probably the most outstanding figure among American physicists. He was 66 years of age.

Karl Taylor Compton was born on September 14, 1887, at Wooster, Ohio, and graduated Ph.B. in the College of Wooster in 1908, taking his M.S. degree at the same college in the following year. He remained there for a further twelve months as instructor in chemistry, and then took a similar appointment in physics at Reed College, Portland, Oregon, which he held until 1915. He then went to Princeton University as assistant professor of physics, where he succeeded in 1919 to the chair of physics, which he held until 1930, when he was appointed President of the Massachusetts Institute of Technology. What that unique Institute owed to him during his 19 years' presidency is difficult to express in a few words; but the position gave him the opportunity to apply in practice the principle, in which he was an ardent believer, that science was not an esoteric study, divorced from daily human affairs, but the essential key to the advancement of civilisation, the promotion of commercial development, and the general enjoyment of a fuller life. There can be few instances in history of such an effective liaison between pure science, true education, technical production, high financial administration, and the practical aspects of national policy in the person and personality of one man.

His peculiar abilities in this direction showed themselves at comparatively an early age. During the first World War, he served for a short time with the Signal Corps of the United States Army, but in 1918 was seconded to the American Embassy in Paris as associate scientific attaché; an experience which was, doubtless, a useful introduction to diplomatic as well as military and scientific circles. As President of M.I.T. he was brought into direct touch with all branches of government and of commerce, finding solutions to their scientific problems, and many were pleased to enlist his personal co-operation by appointing him to their directorates. Between the wars, for example, he was consulting physicist to the United States Department and also to the General Electric Company; and, at various periods, but more especially since his retirement from the Presidency of M.I.T., he was a director of the Federal Reserve Bank of Boston, the John Hancock Mutual Life Assurance Company, the General Foods Corporation, the McGraw-Hill Publishing Company, and the General Motors Corporation, among others, and a trustee of the American Optical Company.

For eleven years, from 1935 to 1945, Compton was a member of the Advisory Committee of the United States Weather Bureau, and for 17 years, 1931-47, of the Visiting Committee of the National Bureau of Standards. During the second World War, his official appointments were numerous and of the first importance, including the chairmanship of the United States Radar Mission to the United Kingdom in 1943 and membership of the Scientific Intelligence Mission to Japan in 1945. He was the Chief of the Office of Scientific Research and Development from 1943 to 1945, and the Government's principal adviser on the testing and use of atomic bombs. He resigned his position at M.I.T. (while retaining its chairmanship) in order to become head of the Research and Development Board of the United States National Military Establishment, after having been, for the previous eight years, an active member of the National Defense Research Committee. Despite these pre-occupations, he could always find time to support the extension of scientific research in other directions, pure or applied, and there was hardly any such activity of note with which he was not associated in some way; for example, he was chairman of the New Products Committee of the New England Council and a trustee of the New England Industrial Research Foundation, of the Edison Foundation, the Ford Foundation, the Sloan Foundation, and the Sloan-Kettering Institute for Cancer Research. He was a trustee, too, of Princeton University, and a past President of the American Physical Society, the American Association for the Advancement of Science, and the American Society for Engineering Education. He was also a member of the American Society of Mechanical Engineers and of the American Institute of Electrical Engineers, and was the first regional chairman (of the New England Committee) in the American Newcomen Society, an office which he held for 20 years, until his death.

The honours that were conferred upon him are far too numerous to list *in extenso* – he held more than 30 honorary degrees, including one from the Finnish Institute of Technology. He was made a C.B.E. in 1948, a Commander of the Royal Norwegian Order of St. Olav in the same year, and an Officer of the French Legion of Honour in 1951. He visited the United Kingdom on several occasions and always was a welcome visitor. One of these occasions was in 1943, when he came as Pilgrim Trust Lecturer to the Royal Society. The most recent was as lately as February of the present year, when the Parliamentary and Scientific Committee held a reception in his honour. His was a vivid and friendly personality, whose loss will be widely regretted in many circles, and deeply felt by those who knew him more intimately.

ELECTRICAL ACCIDENTS IN MINES

Primary Causes: Misuse, Negligence, Ignorance

The latest report* of the electrical inspector of mines deals with the year 1951. It is dated October, 1953, and was published on May 31, 1954. No-one, therefore has any reason to be congratulated on their celerity in preparing, or printing, this 26 page document. It is reported that at June 30, 1951, the number of electric motors installed at coal mines was 97,183, of a total horse power of 3,184,630. The corresponding figures for the year 1950, were 92,499 and 3,070,625. In view of the extensive mechanisation which has been carried out in recent years, it is probable that the figures for 1954 are considerably higher than those for 1951. A matter of interest and importance is that the extending use of electricity both underground and on the surface, which has now been proceeding for many years, has not resulted in any progressive increase in the number of fatal electrical accidents. The totals for the individual years from 1945 to 1951, were 5, 4, 5, 3, 1, 4, 5.

The figures for non-fatal accidents are not so satisfactory. The total for 1951 was 82, whereas the average for the years 1945 to 1950 was 66·3. The report lists the contributory causes of the various accidents. Of the 82 non-fatal accidents in 1951, 26 were due to "misuse, negligence, ignorance." Three of the five fatal accidents are attributed to the same causes. The contributory cause responsible for the largest proportion of non-fatal accidents, 29 out of 82, was "organisation and lack of equipment." Only 6 were due to "design or unsuitability of apparatus." Switchgear and fuses were involved in 38 out of the 82 accidents and flexible cables and plugs in 19.

The above figures for non-fatal accidents include "dangerous occurrences" and apparently some of these latter did not result in personal injury as the number of persons injured in 82 accidents is given as 71. Of these no less than 33 were electricians. Concern has been expressed at the increasing number of electricians involved in accidents. The figure has shown an almost progressive increase over recent years. It has been suggested that they may be due to the increasing use of electrically-driven plant at the coal-face, but the records do not support this idea. In the period 1940-1949, of accidents to electricians, 137 were underground and 100 on the surface, but of the underground accidents, the larger numbers were on roadways or due to haulage. Of the 137 underground accidents, 77 were due to negligence and the same cause was responsible for 59 of the surface accidents.

The report contains detailed accounts of ten accidents. In two of these, apprentices were involved and, in one of them, the life of the accompanying electrician was saved by the prompt action of the apprentice. The accident was due to a dangerous action on the part of the electrician, and it is noted that seeing examples of bad practice by skilled men is not good training for apprentices. There is little doubt but that a considerable proportion of the accidents to electricians are due to over-confidence. The record of plant and apparatus as revealed in the report is good, but it is recorded that in some cases unauthorised alterations to certified apparatus are being made, and that circuits approved as intrinsically safe are being altered without application to the Ministry.

* *Report of H.M. Principal Electrical Inspector of Mines for the year* 1951. H.M. Stationery Office (1*s.* 6*d.*).

INSTRUMENTS AND PRINTING EXHIBITIONS IN 1955

Among the large exhibitions due to take place in London in 1955 are the next biennial British Instrument Industries Exhibition, which will be held at Earl's Court, Kensington, S.W.5, from Tuesday, June 28, to Saturday, July 9, and the Tenth International Printing Exhibition, which will be held at Olympia, Kensington, W.14, from Tuesday, July 5, to Saturday, July 16.

The Instrument Industries Exhibition will cover all spheres of instrumentation in pure and applied science, including navigation equipment; medical instruments; photographic apparatus; temperature, pressure and flow apparatus; and equipment used for scientific research.

Both exhibitions are being organised by F. W. Bridges and Sons, Limited, Grand Buildings, Trafalgar-square, London, W.C.2.

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PERSONAL

AIR COMMODORE MICHAEL WATSON, C.B., C.B.E., has been appointed head of a new division of Decca Radar Ltd., 1-3 Brixton-road, London, S.W.9, to be known as the RADAR SYSTEMS DIVISION. Air Commodore Watson will be assisted by MR. S. J. KYTE.

SIR RONALD GARRETT has been re-elected chairman of the General Committee of Lloyd's Register of Shipping for the ensuing year, SIR GUY ROPNER has been re-elected deputy chairman and chairman of the Sub-Committees of Classification and MR. R. M. TURNBULL vice-chairman of the Sub-Committees of Classification. MR. A. E. M. GALE has relinquished the position of deputy chairman and treasurer and has been succeeded by MR. J. E. GREEN. MR. P. E. CLEMENT, who has been secretary since July, 1945, has retired, on account of ill-health and has been succeeded by MR. W. J. FERGUSON, M.Eng., who is now to combine the office of secretary and chief executive. MR. W. E. J. LEWIS, B.Sc., principal surveyor for metals, retired on June 30 on reaching pensionable age. His successor is MR. T. W. BUSHELL.

ALDERMAN P. A. SANDERS, C.B.E., D.L., M.I.Mech.E., deputy chairman of Davey, Paxman & Co. Ltd., Standard Ironworks, Colchester, and a director of other companies, was created a Knight Bachelor in the Birthday Honours List.

DR. S. WHITEHEAD, director of the British Electrical and Allied Industries Research Association, 5 Wadsworth-road, Perivale, Greenford, Middlesex, has been elected chairman of the Committee of Directors of Research Associations.

The Ministry of Supply announce that DR. C. H. JOHNSON, who is at present chief superintendent of the Explosives Research and Development Establishment, Waltham Abbey, has been appointed to succeed MR. C. S. BRYANT as director of materials and explosives research and development, with effect from July 1. Mr. Bryant retired from the public service on June 30. MR. L. T. D. WILLIAMS has been appointed to succeed Dr. Johnson as chief superintendent, Explosives Research and Development Establishment.

MR. I. A. MARRIOTT has been elected to the board of Wellworthy Ltd., Lymington, Hampshire.

MR. W. K. G. ALLEN, M.I.Mar.E., A.M.Inst.N.A., joint managing director of W. H. Allen, Sons and Co. Ltd., Bedford, has been elected a director of Whessoe Ltd.

MR. H. B. CLARK has retired from the board of Dewrance & Co. Ltd. MR. J. STEWART ROBERTSON has been appointed a director of the company.

MR. A. W. MCMURDO, M.B.E., B.Sc., A.M.I.C.E., has been made district engineer, Shrewsbury, Western Region, British Railways.

MR. W. CUSWORTH has been appointed a director of Buckley and Taylor Ltd., Castle Iron Works, Oldham, as from July 1.

MR. R. IVOR SLATER has been elected a director of Moorwoods Ltd., Harleston Street, Sheffield, 4, as from July 1.

MR. HAROLD T. JOHNSON, manager of the forward planning and development division of Vauxhall Motors Ltd., Luton, Bedfordshire, since 1953, has been elected to the board of directors.

MR. W. C. BENNETT, purchasing manager of Standard Telephones and Cables Ltd., New Southgate, retired on June 30, after 44 years of service. His successor is MR. S. F. MONK.

MR. B. F. SLATER, late sales engineer to Borg and Beck Co. Ltd., Leamington Spa, has joined J. and H. McLaren Ltd., Leeds, in a similar capacity and will represent the company in the West of England.

DR. J. M. S. RISK has been appointed controller of accounts of the Brush Group Ltd., and a director of Associated British Oil Engines Ltd. He succeeds MR. MAURICE TATTERSFIELD, who is now deputy managing director of the Brush Electrical Engineering Co. Ltd., Loughborough. Dr. RISK took up his duties on July 1.

MR. JACK ETCHELLS has been made deputy manager of the Glasgow branch of the British Tyre and Rubber Co., Ltd., Herga House, Vincent-square, London, S.W.1. He was a test pilot to the Ministry of Supply during the last war and was awarded the Distinguished Flying Cross.

MR. CYRIL H. WARRILOW has been appointed group sales executive to the Rootes Group, with headquarters at Humber Ltd., Ryton, Coventry.

MR. J. F. C. GOODMAN has resigned his appointments as director and sales director of Bound Brook Bearings Ltd., Trent Valley-road, Lichfield, Staffordshire. The company is a subsidiary of Birfield Industries Ltd.

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BUSINESS CHANGES

THE MAGNESIUM ADVISORY COMMITTEE, formed early in 1952, has now been reconstituted as the MAGNESIUM INDUSTRY COUNCIL. The purpose of the Council is to promote the production and use of magnesium and its alloys, and its services are available to industry and to the ministries responsible for the defence programme. The chairman is MR. E. PLAYER, Birmid Industries Ltd., and the secretaries, WENHAM BROTHERS & CO., 21 Bennett's-hill, Birmingham, 2.

The address of the JUNIOR INSTITUTION OF ENGINEERS is now 14 Rochester-row, Westminster, London, S.W.1. (Telephone: VICtoria 0786.)

From August 1, the branch office of the B.S.A. TOOLS GROUP, Toronto, Canada, at present known as BURTON GRIFFITHS & CO. LTD., will operate under the name of B.S.A. TOOLS LTD. There will be no change of staff, and the office will continue under the management of MR. E. J. STOKES, at 19 Melinda-street, Toronto, 1. (Telephone: Empire 6—0984.)

THE HUGHES TOOL CO., producers of oil-drilling equipment, Houston, Texas, U.S.A., have been allocated a Government-built factory at Castlereagh, near Belfast. This is nearing completion and covers an area of over 86,000 sq. ft.

THE SUNDERLAND SHIPBUILDING AND DRY DOCKS AND ENGINEERING CO. LTD., is the title of a new holding company designed to bring about closer working between the Sunderland firms of J. L. THOMPSON AND SONS LTD., and SIR JAMES LAING & SONS, LTD., shipbuilders; T. W. GREENWELL & CO. LTD., ship repairers and dock owners; JOHN LYNN & CO. LTD., and the SUNDERLAND FORGE AND ENGINEERING CO. LTD., engineers; and the WOLSINGHAM STEEL CO. LTD., steel manufacturers. The new company's registered office is at Messrs. Laing's shipyard. There will be no changes in the managements of the individual companies which will carry on as hitherto under their own identities. The chairman of the new company is SIR HENRY WILSON SMITH, K.C.B., K.B.E.

THE QUASI-ARC CO., LTD., Bilston, Staffordshire, have opened a new store at the premises of their associated company, FUSARC LTD., Team Valley, Gateshead, 11, Co. Durham.

BIRWELCO LTD., Chester Street, Aston, Birmingham, 6, are now manufacturing under licence the Petrochem-Isoflow furnaces, previously obtainable only from the United States.

HOOVER LTD., Hoover House, 211-213 Regent-street, London, W.1, announce the recent opening of the new factory of HOOVER INDUSTRIES PTY., LTD., at Meadowbank, on the Parramatta River, Sydney, Australia. The associated company HOOVER (AUSTRALIA) PTY. LTD., will move shortly to the new building from central Sydney.

THE PLESSEY CO., LTD., Ilford, Essex, announce that a new division of the company has been established. It is to be known as the SWINDON COMPONENTS DIVISION, Kembrey Street, Swindon, Wiltshire; (Telephone: Swindon 3461), and will be responsible for the development, manufacture and sale of electrolytic and paper capacitors and moulded track potentiometers. MR. O. G. COX has been appointed general manager.

MARINE TURBINE RESEARCH

WORK AT PAMETRADA DURING 1953

The Progress Report of Parsons and Marine Engineering Turbine Research and Development Association (PAMETRADA) for 1953, issued recently, indicates the wide range of research which is being carried out at the Research Station at Wallsend-on-Tyne. The experimental high-temperature steam turbine (Pamela) has been brought into operation, and the 3,500 shaft horse-power gas turbine has been coupled up to reduction gearing and ahead and astern hydraulic couplings. Encouraging results have been obtained from burning heavy fuel with different additives.

Ship owners have been showing a marked interest in the work of the Association and the report expresses the hope that their interest will be stimulated further by the nomination by the General Council of British Shipping of two representatives to the Research Board.

Early in the year approval was obtained for a design of epicyclic and reverse gearing but the consent of the Research Board has not yet been given for the construction of this machinery, though the design is now complete. New research schemes that received approval were: (i) a new type of turbine-cylinder joint fastening; (ii) model tests of double-casing high-pressure turbine; (iii) threads and treatments for bolts for high-temperature turbine; and (iv) a unit tubular heat exchanger for gas turbines.

WORK OF DESIGN DEPARTMENT

During the year 64 design inquiries were considered. Arising from these, nine definite orders have been placed with member firms or licensees and a similar number are likely to result in contracts, several relating to naval vessels for foreign governments. Among the orders placed for ships to be equipped with Pametrada machinery is the new Holland-America liner to be built by Wilton Fijenoord, Schiedam.

A number of ships with Pametrada machinery were commissioned during 1953, including the Royal Yacht Britannia, built by John Brown and Company, Limited, at Clydebank. The Olympia, the new flagship of the Greek line, was completed by Alexander Stephen and Sons, Limited, of Linthouse. The 33,000-ton tanker World Enterprise was built by Vickers-Armstrongs Limited, for the World Tanker Corporation and the engines by Parsons Marine Steam Turbine Company, Limited, with machinery designed by the Association to take steam at 850 lb. per square inch and 850 deg. F. The new Bergen steamer Leda was completed by Swan, Hunter and Wigham Richardson, Limited, and engined by the Wallsend Slipway and Engineering Company, Limited. Two of the 18,000-ton tankers for the Anglo-Saxon Petroleum Company, Limited, mentioned in the Progress Report for 1951, were completed, namely, Harpa (Harland and Wolff) and Hemidonax (Cammell Laird). The latter firm also delivered to the Eagle Oil Company two tankers equipped with similar machinery.

Two destroyers for Her Majesty's Navy, Decoy and Delight, were commissioned during 1953. The Delight has machinery similar to H.M.S. Daring, and Decoy is equipped with machinery made by the English Electric Company, Limited. The Association completed shore trials on the latter machinery in 1951. Vickers-Armstrongs Limited completed the first of three fast naval vessels for the Venezuelan Government, fitted with machinery designed specially to give good economy at very low cruising powers without the complication of cruising turbines or the use of very highly-stressed alloy-steel rotors.

New designs completed during 1953 included one for the vessel which Fairfield Shipbuilding and Engineering Company, Limited, are building for the Canadian Pacific Steamship Company, and the two tankers which Vickers-Armstrongs Limited are building for the North American Shipping and Trading Company, each likely to be of deadweight capacity materially greater than 44,000 tons. Single-cylinder turbines, of the type first fitted in the British Railways vessels Normannia and Lord Warden, were designed, one for a vessel building at Cammell Laird and Company, Limited, for the Isle of Man Steamship Company, Limited, and the other for a package freighter to be constructed by John Inglis and Company, Limited, Toronto, licensees of the Association, for the Canadian Shipping Line.

TURBINE-BLADE VIBRATION

The first case of turbine blade failure, due to vibration, in a Pametrada turbine was reported during the year. The blading was of the reaction type but no case of failure in impulse blading is known. The blading details in this instance were in accordance with the usual marine practice except for a small detail of dimension. However the material used was Monel, which is known to be inferior to stainless iron in its vibration properties when applied to turbine blading.

On this occasion it was found possible for the first time to make an estimate, likely to be reasonably accurate, of the actual vibration stresses to be expected. From this it was found that at one particular speed within the service range a blade stress of 12 tons per square inch could have been expected, due to the combination of centrifugal loading with steam bending stress enhanced by resonant vibration. Since the failure occurred some years after the vessel went into service it is considered that it would be accounted for by a stress of this order, seeing that the calculated figure represented an estimate of the true stress and not merely a nominal figure derived from a design formula. The design was modified to bring it in line with other sizes of similar blading, and additionally the material was changed to stainless iron, and it is confidently expected that there will be no further trouble.

An interesting development during the year concerned the method of handling turbines under standby conditions. For many years it had been customary to reduce the condenser vacuum to about 10 in. in order to maintain the turbines in a reasonably warm condition when stopped for short periods. It has been realised, however, that this condition could only be produced by allowing air to enter the condenser, which, unfortunately, causes corrosion in the internal parts of the boilers. One solution that has been adopted in a number of vessels, is the installation of a small de-aerator for port use.

The Association has found, by experimenting with small steam nozzles fitted below the water surface in the condenser sump, that only a small steam flow is required to maintain the water close to boiling point when there is little or no vacuum in the condenser. Consequently the turbine temperature may be kept at a reasonably high level. This development, for which an application for patent protection has been made, is likely to be applied shortly in a number of vessels for service use.

The double-casing type of high-pressure turbine which was mentioned in the Progress Report for 1952 in connection with the 950-deg. F. installations now being built at R. and W. Hawthorn Leslie and Company, Limited; Scott's Shipbuilding and Engineering, Company, Limited, and Wilton Fijenoord, Schiedam, for the Overseas Tankship Corporation, has been further developed during the year. A quarter-size scale model has been built of steel to enable load and thermal testing to be carried out by the Research Department. The model has been under a dead-load test supporting a total weight of 1 ton. Subsequently a more severe test was applied in a testing machine with a load of 5 tons corresponding to an acceleration of 20*g* on the full-scale turbine; this load was carried without distress and without any permanent set. When the thermal tests have been completed the load tests will be continued until signs of a permanent set are observed.

In the gas-turbine field a number of design projects have been investigated during the past year. Modifications to the existing 3,500-s.h.p. set, referred to in ENGINEERING, vol. 176, page 491 (1953), have been schemed out to improve its manœuvring characteristics. These include gashing the rotors to reduce thermal inertia and the development of a special blade-root fixing to enable the original blades to be used. An alternative design of casing has also been prepared on lines similar to those of the double-casing high-pressure steam turbine.

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LAUNCHES AND TRIAL TRIPS

S.S. "IRISH HOLLY."—Single-screw oil tanker for coastal service, built by William Gray & Co., Ltd., West Hartlepool, for the Irish Shipping, Ltd., Dublin. Main dimensions: 310 ft. between perpendiculars by 46 ft. by 19 ft. 3 in. to upper deck; deadweight capacity, about 3,350 tons on a draught of 17 ft. 3½ in. Triple-expansion steam engine, constructed by Smith's Dock Co., Ltd., South Bank-on-Tees, and installed by the shipbuilders. Steam supplied by two oil-fired forced-draught Scotch boilers. Service speed, about 11½ knots. Trial trip, May 4.

S.S. "PIET RETIEF."—Single-screw trawler, built by Cook, Welton and Gemmell, Ltd., Beverley, Yorkshire, for Irvin and Johnson, Ltd., Cape Town. Main dimensions: 141 ft. between perpendiculars by 27 ft. by 14 ft. to main deck; gross tonnage, about 490; fishroom capacity, 5,910 cub. ft.; capacity of offal room, 2,708 cub. ft. Separate quarters provided for European and native crews. Triple-expansion steam engine constructed by C. D. Holmes & Co., Ltd., Hull. Steam supplied by one coal-burning Scotch boiler. Launch, May 20.

M.S. "ADJUTANT."—Single-screw cargo vessel, built by S. P. Austin and Son, Ltd., Sunderland, for the General Steam Navigation Co., Ltd., London, E.C.3. Main dimensions: 246 ft. by 40 ft. by 15 ft. 3 in. to main deck; deadweight capacity, 1,420 tons. Six-cylinder single-acting two-stroke Diesel engine, constructed by Sulzer Brothers, Ltd., Winterthur, Switzerland, and installed by the shipbuilders. Service speed, 13 knots. Trial trip, May 20.

M.S. "EDDYSTONE."—Single-screw cargo vessel, built by the Grangemouth Dockyard Co., Ltd., Grangemouth, for the coastal trade of the Clyde Shipping Co., Ltd., Glasgow. Main dimensions: 208 ft. 5 in. by 38 ft. 5 in. by 13 ft. 10 in.; gross tonnage, 968. Seven-cylinder Diesel engine, developing 1,215 b.h.p. at 275 r.p.m., constructed by British Polar Engines, Ltd., Glasgow. Speed on trial, 13 knots in ballast condition. Trial trip, June 3.

M.S. "TINTAGEL CASTLE."—Single-screw non-insulated cargo vessel, with accommodation for twelve passengers, built and engined by Harland and Wolff, Ltd., Belfast, for the Union-Castle Mail Steamship Co., Ltd., London, E.C.3. Second vessel of an order for two. Main dimensions: 465 ft. between perpendiculars by 65 ft. 6 in. by 41 ft. 6 in. to shelter deck; gross tonnage, 7,450. Eight-cylinder double-acting two-stroke heavy-oil engine. Trial trip, June 5.

Meeting of the Iron and Steel Institute in Sweden (continued from page 806 in our issue of June 25)

TREATMENT OF IRON-ORE FINES

ADVANTAGES OF PELLETISING

Continuing our report of the meeting of the Iron and Steel Institute, held in Sweden from June 7 to 18, we have now to deal with the joint technical session of the Institute and Jernkontoret held at Riksdagshuset, Stockholm, on the morning of Saturday, June 12. The proceedings were entirely in English. The President of the Institute, The Hon. R. G. Lyttelton, occupied the chair. In his introductory speech he stated that Mr. E. Wijkander, the President of Jernkontoret, had been made an honorary vice-president of the Institute and that Mr. Gösta Frisell, formerly member of Council and managing director of Jernkontoret, who was responsible for the organisation of the meeting, had been elected an honorary member of the Institute. He also announced that the secretary of the Institute, Mr. K. Headlam-Morley had been created an Officer of the Ancient Order of Vasa for his work in helping to promote cordial relations between Swedish and British metallurgists. The President's final announcement noted that two of the members of the Institute present at the meeting had figured in the Queen's Birthday Honours List, namely: Mr. Frederick Scopes, managing director, the Stanton Ironworks Co., Ltd., and President of the Joint Iron Council, who had been created a Knight Bachelor and Group Captain Geoffrey Shaw, D.F.C., D.L., M.A., chairman and joint managing director, W. Shaw, & Co., Ltd., Middlesbrough, who had been made a C.B.E.

BRITISH AND SWEDISH PRACTICES

The first three papers presented all dealt with the pelletising of iron-ore fines and were jointly discussed after presentation. The first paper was entitled "Aspects on Pelletising of Iron-Ore Concentrates" and was by Dr. Magnus Tigerschiöld, of Trafikaktiebolaget Grängesberg-Oxelösund and Luossavaara-Kiirunavaara A.B. The author stated that there was still much work to be done in the laboratory as well as on the design and operation of full-scale equipment, but it seemed clear that pelletising in shaft furnaces would become an important complement to existing methods for the agglomeration of iron-ore fines. This would be the case especially when utilising rich magnetite concentrates. The decision to build huge plants in the United States and Canada was based on the conviction that the pelletising method was the best so far found for agglomerating finely-milled magnetite concentrates, and also on the experience gained when the pellets had been tried in blast furnaces and as charge and feed ore. In Sweden, large reserves of magnetite ore were available which, in most cases, could easily be concentrated to an iron content of over 60 per cent. without grinding the product to a high degree of fineness. Thus, most of these concentrates could be sintered effectively for blast-furnace use according to the classical methods. An exception was the Malmberget concentrate, which had to be very finely ground when efficient removal of phosphorus was required.

The second contribution, entitled "The Development of a Pelletising Process for Fine Iron Ores," was a paper of the Burden Committee of the Ironmaking Division of the British Iron and Steel Research Association by Mr. J. M. Ridgion, Mr. E. Cohen and Mr. C. Lang. The paper, which was presented by Mr. Ridgion, contained an account of laboratory and pilot-scale work on the pelletising of Sierra Leone and Sydvaranger concentrates and on flash-roasted pyrites residues. The authors stated that their work had shown that both hematite and magnetite concentrates could be pelletised successfully on a pilot-plant scale. The translation of the process to a commercial scale might well bring to light further problems peculiar to larger units, but the experience already gained not only provided a basis for development, but also gave a guide to the general economic prospects of the process. The problem of processing imported concentrates in the United Kingdom was very different from that facing United States and Swedish producers. Current imports of concentrates were of the order of only 500,000 tons a year, although circumstances might arise in which this figure would increase. With a total sintering capacity of 4½ million tons and a prospective increase to 8 million tons by 1955, these concentrates could be agglomerated by sintering alone or mixed with the screenings of other ores. Calculations suggested that pelletising material of this character in an installation producing about 250,000 tons a year might prove to be more economical than sintering, but that the difference in cost would not be large. The observed superiority of pellets over sinter in regard to porosity and degree of oxidation suggested that improved blast-furnace efficiency might well be the vital factor in encouraging the adoption of the process, but in the absence of operating experience it was not possible to make due allowance for this.

The third paper was by Mr. A. Stirling, of the department of research and development of Stewarts and Lloyds Limited, and described the experimental and pilot plants, at the Corby Works of the firm, for "The Pelletising of Northampton Sand Ironstones by Vacuum Extrusion." The author stated that in a vacuum-extrusion plant the ore was subjected to vacuum in a de-airing chamber which was sealed on the inlet side by a cone, or perforated shredding device, and on the outlet side by the die itself. While columns of a variety of profiles could be extruded separately or simultaneously, the most convenient shape for the pellet was a simple cylinder. The subsequent handling of the extruded pellets depended on the properties of the ores being agglomerated, the extrusion practice in terms of the use of binders, and other factors. The obvious aim, however, was to produce self-hardening pellets which became good blast-furnace burden material in the shortest possible time. The process did not require more than ordinarily experienced and conscientious operators. The production costs of unfired pellets were likely to be attractive, but the additional charges for firing might well be greater than was worth while. The immediate aim at Corby was to have further experience of unfired pellets in a blast furnace and, moreover, to use this method of agglomeration, as circumstances allowed, for the enrichment, the fluxing, and even the fuelling of that part of the burden which was supplied by the ore fines.

DISCUSSION

The discussion was opened by Mr. F. H. Saniter, who stated that, at first sight, sintering and pelletising seemed to be different processes. At the symposium on sintering held in London recently, however, the importance of permeability had been stressed, and this and similar properties applied also to pelletising. Blast-furnace operators would like to know whether a burden consisting of 100 per cent. pellets was preferable to one consisting of 100 per cent. sinter. Perhaps those engaged in the production of pellets and of sinter could give an answer on that point. The fact that material for pellets had to be reduced to a high degree of fineness had some bearing on the cost, and the relative quantities of fuel used in producing sinter and pellets, also had some influence on costs. Moreover, the firing of the pellets demanded exact temperature control and uniform heat distribution, as Dr. Tigerschiöld had pointed out. A variety of pelletising methods had been discussed and this was all to the good as it made for progress. Those responsible for blast-furnace operation would thus be able to select the method best suited to their needs.

Mr. L. O. Uhrus stated that a temperature of 1,450 deg. C. had been given in the paper by Mr. Ridgion and his colleagues. This appeared to be a very high temperature for a shaft kiln. The next speaker, Dr. H. Wendeborn, mentioned that pelletising plants should be situated not near the iron-ore mines, but near the blast-furnace plant as this gave opportunities for the blending of a number of ore fines from different sources. Mr. Sven Fornander, the director of research of Jernkontoret, who spoke next, referred to the importance of the beneficiation of ore concentrates in Sweden. He added that the production of sponge iron by some of the methods used would be difficult if the pelletising process were not available. The last speaker, Mr. J. E. Astier, said that the cost of grinding ore to the fineness required for pelletising had been mentioned, but it should be remembered that ore for sintering had also to be ground, and the difference in the cost of grinding the ore to the fineness required by each of these two processes was usually not very great.

METALLURGICAL LITERATURE

The next paper considered was by Mr. Einar Ohman, head of the publication and information department of Jernkontoret, Stockholm, and Mr. J. P. Saville, information officer of the Iron and Steel Institute. It dealt with "The Universal Decimal Classification Applied to Metallurgical Literature." In the unavoidable absence of Mr. Saville the paper was presented by Mr. K. Headlam-Morley, supported by Mr. Ohman. The authors explained the need for a rapid and accurate means of classifying metallurgical literature and, after discussing other systems, described the Universal Decimal Classification, or U.D.C. They stated that there were three main principles involved. The first was classification by the analysis of ideas; by this, related concepts and groups of concepts were brought together, and the arbitrary and haphazard systemisation of many other methods avoided. The second principle was universality, in that an attempt was made to include every subject of human knowledge, and to group these subjects from every point of view. The third principle was the use of the decimal point. The whole of human knowledge was divided into ten groups, and each group was subdivided by the addition of decimal places.

There was no discussion on this paper.

To be continued

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MALEIC ANHYDRIDE

New Plant to be Constructed

Monsanto Chemicals, Limited, 8 Waterloo-place, London, S.W.1, has announced that it is shortly to begin construction of a major plant to manufacture maleic anhydride by direct oxidation of benzene. This important chemical has hitherto been obtained as a by-product only, but the new installation will be built specifically for its production and the output should be sufficient to cater for all the known needs of industry in Great Britain.

The new plant, which will be built at the company's Ruabon, North Wales, factory, is part of the continuous programme of expansion which has been carried out and on which £5,000,000 has already been spent. Maleic anhydride is a basic industrial chemical which is used as a raw material for the manufacture of alkyd and polyester resins employed in the paint and plastics industries, and as a starting point for various important organic syntheses.

BOOK REVIEWS

Increased Thermal Efficiency of Solid Fuel through Gasification. Technical Progress in the U.S.A. and in Europe. *Organisation for European Economic Co-operation, 2 Rue André-Pascal, Paris* (16e); and *H.M. Stationery Office, Kingsway, London, W.C.2.* (8*s.* 6*d.*)

This clumsily-titled book is concerned with the practicability and efficiency of various methods of gasifying small and low-grade fuels, not with increasing the thermal efficiency of such fuels; that expression does not appear to have any meaning. The book has been compiled by a working party set up by O.E.E.C. on the suggestion of the Belgian delegation. (Incidentally, it is stated that the proposal was made on October 5, 1954!) The point was that any efficient processes of gasifying such fuels as fines from non-coking coals, fines from lignite and shale, slurry and peat would be of economic importance. It is suggested that in the investigation of this subject, co-operation between groups from different countries would be of value as the expense involved might be too great to be borne by even a number of firms from any single country. As a preliminary to such activities, the working party have collected information about processes developed, or under trial, in various countries, and this book records the information.

It is evident from this compilation that much work has been done and is being done on the problem with which the working party are concerned. Descriptions are given of plant and methods developed in Germany, France, the United States and Great Britain by commercial firms and public organisations such as the Bureau of Mines and the Fuel Research Station. Preceding the descriptions of actual plants, the longest section of the booklet discusses the practical and theoretical advantages and disadvantages of various methods of gasification. Diagrammatic representations and flow diagrams are given so that this section constitutes a valuable treatise on the subject. In a separate section, the possibilities of European co-operation are discussed. It is pointed out that the members of the working party represent the industries of their respective countries and that the aims of some of these differ greatly from those of the others. The requirements of town-gas authorities are not the same as those of manufacturing industry; but whatever may be done towards international co-operation, there is no question about the value of the review of the subject presented in this publication.

Questions and Answers on Power Station Practice and Plant. By T. H. CARR. *George Newnes, Limited, Tower House, Southampton-street, Strand, London, W.C.2.* (6*s.*)

Questions and Answers on Distribution and Use of Electric Power. By T. H. CARR. *George Newnes, Limited, Tower House, Southampton-street, Strand, London, W.C.2.* (6*s.*)

These two books have been compiled for the use of engineers and others who are concerned with the generation, transmission and distribution of electricity and they are intended to provide concise information, in the form of questions and answers, on a variety of technical, legal, economic and organisational problems. Fairly complete indexes are provided and it must be assumed that the users of these books will first consult the indexes and then turn to the appropriate page for what is required. It may, of course, be necessary to go farther and refer to some text-book in which the subject is dealt with in greater detail. Alternatively, of course, it is possible to read the book straight through. In both cases the results will be rewarding, although the answers suffer in some cases (we suppose inevitably) from conciseness; and the arrangement of the sections sometimes appears to be a little illogical. We suggest that this matter might receive consideration in future editions.

On the other hand, we have not been able to discover any serious error or misprints, although the nature of the series capacitor and its uses might be more fully explained. For some reason the selenium rectifier is not mentioned and something might have been said about the use of the mercury rectifier as an inverter. The information on the principal types of conductor might well be expanded in view of certain new arrangements which are being used on extra high-voltage systems. These are, however, relatively minor points and both books may be recommended to those for whom they are intended.

Electrical Installation Work. By T. G. FRANCIS. *Longmans, Green and Company, Limited, 6 and 7 Clifford-street, London, W.1.* (12*s.* 6*d.*)

The second edition of this very practical work contains additional material in the form of questions from examination papers, and references to the twelfth edition of the I.E.E. Regulations, which have been published since the first edition appeared, have been included. The work is a text-book for the course in electrical installation leading to the Certificate of the City and Guilds of London Institute. It sets out in 17 chapters the complete syllabus of the course. The illustrations are clear and numerous.

An introduction gives an outline of the generation of electricity and its supply, and also the regulations of various bodies which have to be observed. The first chapter discusses the different distribution systems in use and the second deals with internal distribution in both domestic and industrial buildings. There are diagrams of circuits for various purposes. The third chapter follows naturally with a description of the types of conductor and cables in use and explains the purposes of each. Then come chapters on the forms of conduit and other wiring systems and the accessories which go with each form. Both built-in and external systems are included. Testing the circuit after completion is fully described, as also are the instruments used.

Chapters follow dealing with lighting and heating, both filament and discharge lamps being considered, together with water and space heating. A table is given for calculating the loading required for heating a room under different conditions. Direct and alternating-current machines, both motors and generators, are simply and clearly described in succeeding chapters, after which primary and secondary cells are dealt with. The installation of various types of electric bells and telephones is considered in some detail, while one chapter is devoted to the tariffs in operation among different classes of consumer. Throughout each chapter there are worked examples, and the book concludes with the examination questions already mentioned.

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BOOKS RECEIVED

Alternating Current Electric Motors. Application and Maintenance. *Brook Motors, Limited, Empress Works, Huddersfield.* (15*s.*)

A Résumé of Maximum Lift Data for Symmetrical Wings with Various High Lift Aids. Note No. 5. By T. NONWEILER. *The Librarian, The College of Aeronautics, Cranfield, Bletchley, Buckinghamshire.* (5*s.*)

Rules and Regulations for the Construction and Classification of Steel Ships. 1954 edition. *Lloyd's Register of Shipping, 71 Fenchurch-street, London, E.C.3.* (42*s.*)

F.B.I. Overseas Scholarships. Training Overseas Engineers as an Aid to Future Exports. *Federation of British Industries, 21 Tothill-street, London, S.W.1.* (Free on application.) (Reviewed in ENGINEERING, June 4, page 706.)

Raw Materials for Electric Cables. By A. KING and V. H. WENTWORTH. *Ernest Benn, Limited, Bouverie House, Fleet-street, London, E.C.4.* (42*s.*)

V2. By Major-General WALTER DORNBERGER. Translated from the German by JAMES CLEUGH and GEOFFREY HALLIDAY. *Hurst and Blackett, Limited, Stratford-place, London, W.1.* (16*s.*)

Conference on Work Study, Harrogate, 1954. Papers presented. *British Institute of Management, 8 Hill-street, London, W.1.* (7*s.* 6*d.*)

TRADE PUBLICATIONS

Finned Tubes for Heat Exchangers. Imperial Chemical Industries Ltd., Imperial Chemical House, Millbank, London, S.W.1, have issued a booklet describing their "Integron" high and low fin tubing for heat exchangers. The physical properties of the various alloys available are stated and fitting instructions are given.

Automatic Telephone Exchange Equipment. Communications Systems, Ltd., Strowger House, Arundel-street, London, W.C.2, have issued a booklet describing in detail the Strowger private automatic telephone exchange equipment, which has 200 lines and 20 connecting links.

Rectifiers for Mining Service. The Hackbridge and Hewittic Electric Co. Ltd., Walton-on-Thames, Surrey, have published a brochure describing their rectifier equipment for mining service. Types are available up to 30,000 kW capacity. They can be used for traction supplies or for battery charging where trolley wires are not suitable.

Classification of Fine Powders. International Combustion Ltd., 19 Woburn-place, London, W.C.1, have issued a leaflet describing a laboratory elutriator for accurately classifying fine powders into three grades. A special model is available for powders soluble in water.

Corrugated Aluminium Sheet. Published by the Northern Aluminium Co. Ltd., Banbury, Oxfordshire, a booklet giving particulars of their range of corrugated aluminium sheeting for roofing and cladding has been received. Types of fastenings are also described and the preparation and finishing discussed.

Relay Maintenance. In order to overcome the difficulty of access for maintenance of flush-mounted relays, A. Reyrolle & Co. Ltd., Hebburn, Co. Durham, have developed a casing in which the relay mechanism can be slid forward on runners. This is fully described in their pamphlet No. 1276. Most types of relay can be accommodated.

Low-Hydrogen Electrodes. Murex Welding Processes, Ltd., Waltham Cross, Hertfordshire, have issued a leaflet describing their "Fortrex 35" welding electrodes. These have a very low hydrogen content and are classed under B.S.639 quality. They can be used with low-alloy steels normally outside the welding range.

Transformers for Electronic Applications. A brochure issued by Radford Electronics, Ltd., 149 Newfoundland-road, Bristol, 2, describes their range of transformers for the electronic industry. About 60 different models are listed, both for high-tension and heater supplies. Performance details are also given.

Pyrometers. The Foster Instrument Co., Ltd., Letchworth, Hertfordshire, have published a new edition of their catalogue of thermo-electric pyrometers. It gives descriptions of pyrometers for many applications; of cables and connecting systems; and of indicating and recording instruments. An appendix shows specimens of recording charts and instrument scales and also gives details of the "non-interchangeable" lead system.

High-Frequency Motor-Alternators. The Electro Dynamic Construction Co., Ltd., St. Mary Cray, Kent, have published a leaflet giving particulars of their range of high-frequency motor-alternator sets. Machines are available with outputs up to 50 kVA and 10,000 cycles.

Electronic Control. Industrial Electronics, Inc., 8060 Wheeler-street, Detroit 10, Michigan, U.S.A., have issued a leaflet describing their Myke-A-Trol electronic control set designed for use with either differential transformers or strain gauges. It contains two relays which can be used for upper and lower limit indication, both being adjustable. An extensive range of other electronic equipment is also made by this firm.

Power Transformers. A booklet issued by the Brush Electrical Engineering Co., Ltd., Loughborough, describes the manufacture of transformers in the power range from 2,000 to 45,000 kVA.

Pulse Equipment. A. E. Cawkell, 6-7 Victory-arcade, The Broadway, Southall, Middlesex, have issued a pamphlet describing in detail their range of special purpose electrical pulse equipment and oscilloscopes. Power supplies, markers and time bases are dealt with.

Transducer System. A publication by Salford Electrical Instruments, Ltd., Silk-street, Salford, 3, Lancashire, describes an electromagnetic transducer system for relaying information up to 1,000 yards. Accuracy is within ± 1 per cent. over large changes of conditions. Heads are available for either pressure or displacement measurements.

STEEL ON THE DEFENSIVE

COMPETITION FROM ALUMINIUM

Output of aluminium has increased by 10 per cent. a year since the beginning of the century; so it has doubled every seven years. This rate of development is comparable to that of the steel industry in the period 1880 to 1910, but since then the rate at which steel production has increased has taken more than 20 years to double itself. The Steel Committee of the Economic Commission for Europe requested a study of the field in which aluminium competes with steel, and the result* is a most stimulating account of the growth of a new industry and a competent analysis of the nature and extent of its competition with the steel industry. The area of the competition is clearly defined and discussed in detail in six broad industrial groups—railways, motor vehicles, shipping, containers, construction and household equipment.

SCALE OF ALUMINIUM PRODUCTION

World production, which totalled 705,000 tons in 1939, was strongly stimulated by war-time demand and had grown to 1·9 million tons in 1943. There was a sharp fall immediately after the war, to 760,000 tons, but the rapid rise in the output of road vehicles and durable consumer goods, together with the effects of the post-war construction boom, led to a recovery to just over 2 million tons in 1952. The plans of each producing country, excluding the U.S.S.R., for increasing capacity, add up to about 4 million tons by 1958-60. This agrees remarkably well with a projection of the historical trend of output – on the basis of an increase of 10 per cent. a year since 1902 – provided, of course, that there is no wide deviation from the general trend owing to booms or slumps.

Subsequent progress may be slower, as aluminium passes from the present period of rapid expansion when new uses are being found and it is gaining wider acceptancy, to that phase in its development when the rate of expansion depends on the rate of increase of the total gross product of the world as a whole, as in the case of steel during the past 40 years. The Paley Report† estimates demand for primary aluminium in the Western World in 1975 at 6 million tons, thus assuming that the rate of growth during the next two decades will average about 5 per cent. per annum, half the rate of progress of the last 50 years. The aluminium industry rejects this view, which implies there are few new fields of applications still undeveloped, and points to the experience of 1953, when aluminium output increased by 30 per cent., to 2·6 million tons, while steel production declined. Available evidence suggests, however, that increased consumption of aluminium last year was due to a large advance in the world output of aircraft, motor vehicles and durable consumer goods, whereas the consumption of steel for armaments was less, and the world output of capital goods was beginning to fall.

PATTERN OF WORLD PRODUCTION OF ALUMINIUM

Production of primary aluminium, which began in France (the ore was named bauxite after the French village, les Baux, where it was discovered), has tended to shift from Europe to North America and to the Far East. In 1939, production in Europe accounted for 54 per cent. of the world total, but, by 1952, it had dropped to 22 per cent. and, on the basis of present plans, will continue to decline. The importance of low power costs to economic production has led to the erection of new plants in areas where there is plentiful and cheap electricity, such as Canada, the Urals and, in Europe, Norway. In Canada and Norway, the cost of electricity represents only about 7 per cent. of the ingot value, but in most other areas it may constitute up to 20 per cent. of the ingot value. As bauxite ore is not generally found where there is cheap power it has become common practice to import ore from far-distant but high-grade deposits, mainly in British and Dutch Guiana, Jamaica, the Gold Coast and, in the case of Soviet Russia, Hungary. It may well be that the industry will develop in the Far East and Africa, where cheap power and high-grade ores could probably be developed side by side. Production of primary aluminium in 1952 and estimate for 1960 are shown below.

World Production of Primary Aluminium by Main Countries in 1939 and 1952 and Estimated Capacity in 1960
(1,000 metric tons)

—	1939	Per Cent.	1952	Per Cent.	1960	Per Cent.
North America						
United States	148	21·0	850	42·2	1,850	40·6
Canada	75	10·7	455	22·6	987	21·6
Total	223	31·7	1,305	64·8	2,837	62·2
Europe (ex U.S.S.R.)						
Austria	4	0·6	38		60	1·3
France	53	7·6	106		118	2·6
West Germany	195	27·6	100		135	3·0
Italy	34	4·8	50		65	1·4
Norway	31	4·4	50		180	4·0
Rest of Europe	60	8·5	102		183	4·0
Total	377	53·5	446	22·2	741	16·3
Asia (ex U.S.S.R.)	32	4·4	51	2·5	128	2·8
Australasia	—	—	—	—	25	0·6
Africa	—	—	—	—	220	4·8
Latin America	—	—	2	0·1	60	1·3
U.S.S.R.	73	10·4	210	10·4	545	12·0
World Total	705	100·0	2,014	100·0	4,556	100·0

The large amount of capital investment required to produce primary aluminium – approximately 1,300 to 1,400 U.S. dols. capital cost per ton of aluminium produced a year,* compared to 100 to 120 U.S. dols. per ton of steel – explains why in all countries the industry is concentrated in the hands of a few big companies. Before the war, the Aluminium Company of America (ALCOA) was the sole producer in the United States. A large expansion programme, subsidised by the United States Government, was carried out during the war and two new companies entered the field – the Reynolds Metal Company and the Kaiser Aluminium and Chemical Corporation. They have been encouraged by the Government to continue production after the war, and other companies are planning to enter the industry. The whole of Canada's output comes from the Aluminium Company of Canada (ALCAN), the expansion of which was considerably assisted financially by the Governments of the United Kingdom and the United States. In France there are only two producers, Péchiney and Ugine, which are closely linked by a joint selling agency, L'Aluminium Français.

Most of these companies wholly or partially own the bauxite mines and aluminium plants from which their smelters are fed, as well as the plants processing and fabricating the virgin metal they produce. In addition, there are financial ties between smelting companies in different countries. The most important company in international affairs is Aluminium Limited (ALTED), a Canadian holding company which, apart from being the sole owner of the Aluminium Company of Canada, and also wholly or partially controlling bauxite mining sites, aluminium plants, processing and fabricating plants throughout the world, has financial interests in smelters in Italy, Norway, Sweden, Brazil, India and Japan. More than 80 per cent. of the primary aluminium entering world trade is currently produced by smelters owned by Aluminium Limited. The French firm, Péchiney, is also interested in Norwegian and Spanish production, and the British Aluminium Company, in Norwegian production. The Swiss Company, A.I.A.G. Chippis, holds interests in German, Austrian, Italian and Spanish production.

Most of the trade in primary aluminium is between four countries, the United Kingdom and the United States, the two great importers, and Canada and Norway, the two great exporters. The post-war tendency in other producing countries has been towards self-sufficiency. In the United Kingdom, imports in 1951 were six-and-a-half times higher than production and, in 1952, eight times higher. United States imports were respectively equal to 15 per cent. and 9 per cent. of United States production in the same years. On the other hand, Canada and Norway, which have the cheapest and most abundant electric power so far developed in the world, exported 70 to 80 per cent. of their ore.

AREA OF COMPETITION WITH STEEL

Expressed in steel equivalent*, world production of aluminium in 1952, represented no more than 2·8 per cent. of world production of steel, but may be between 4 per cent. and 5 per cent. by 1956. Quantitatively, therefore, competition is on a small scale, but such overall comparisons tend to be misleading. The concept of competition involves an economic choice between the two metals, but, in many instances, their physical properties preclude such a choice; examples are the use of aluminium in the electrical and some phases of the aircraft industries, and the use of steel for rails. Furthermore, there are several areas of competition between the different specific aluminium products or alloys and the corresponding specific types and shapes of iron and steel, including alloy steels.

In the electrical, aircraft and chemical industries, very little of the aluminium consumed, accounting for some 22 per cent. of the total consumption, cannot be replaced by ferrous metals; there are certain minor exceptions, such as stainless steel in the chemical industry and steel alloys in some highly-stressed parts of airframes. There is, therefore, some 78 per cent. of total aluminium consumption where there is more or less direct competition with steel, as follows:

—	Estimated Proportion of Total Aluminium Consumption, Per Cent.	Estimated Proportion Directly Competing with Steel, Per Cent.
Construction and building	21	16
Mechanical engineering	10	7
Household equipment	14	11
Road transport	13	11
Packaging and containers	7	2
Ships and railways	3	2
Unclassified	10	—
Total	78	49

* Calculated by multiplying the actual tonnages of aluminium production by the ratio between the density of steel and that of aluminium, i.e. approximately 2.9. However, this should only be considered as applicable for broad global comparisons, since for specific uses the ratio varies from 1·5 to 3 or 4.

* *Competition between Steel and Aluminium.* United Nations, Geneva, February 1954. Prepared by the Industry Division, Economic Commission for Europe. Published by H.M. Stationery Office. [9*s*.]

† *Resources for Freedom.* A Report to the President of the United States by the President's Materials Policy Commission. Washington, June 1942.

* Based on estimates for the Kitimat Scheme

The analysis of the aluminium products directly competitive with iron and steel shows that 28 to 30 per cent. consists of aluminium sheet, 13 to 15 per cent. of light structural shapes and tubes, and 8 to 10 per cent. of castings and forgings. The report estimates the possible tonnages of iron and steel products displaced, on a density basis, at 2 million ingot tons of steel for the production of their flat products (about 3 per cent. of the world production of these products), 900,000 ingot tons for the production of light structural shapes and tubes, and 600,000 ingot tons for castings and forgings, accounting in each of the last two cases for about 1 per cent. of annual world production. There is, however, a tendency for competition to increase, particularly in the rolling-stock, motor-vehicle and shipbuilding industries, in the manufacture of containers and in construction and building.

RELATIVE PRICES AND COSTS

The ratio between the prices of aluminium and steel has steadily narrowed during the last 30 years and is now about 6 : 1 per ton and 2 : 1 per cubic metre. The report argues that the ratio is unlikely to continue to narrow at the same rate, but points out that the incidence of the cost of coal and of labour is lower in aluminium than in steel, and that since these two factors in costs tend to rise during booms, and are inelastic during depressions, the advantage may be with aluminium.

There are other factors in favour of aluminium. The new electricity schemes such as Kitimat and the Volga River are lowering substantially the cost of electric energy. The cost of hydro-electricity at Kitimat is forecast at 0·15 U.S. cent per kWh, compared with an average cost of between 0·2 and 0·3 cent for hydro-electricity in the United States for aluminium production, 1·0 cent average price distributed to industry in the United States, and 0·63 cent average thermal cost in the United Kingdom at power-plant level. The capital cost of producing aluminium is about twice the cost of producing the same value of steel. This is a major factor in the disparity between aluminium and steel costs, but, in the event of a serious recession, the high incidence of capital charges would make worth-while considerable short-term reductions in aluminium prices unlikely to be made on the same scale by the steel industry.

WHERE ALUMINIUM IS GAINING

The report analyses in considerable detail the usage of aluminium in the six industrial groups mentioned above. The use of aluminium for rolling stock, particularly for carriages and specialised (e.g., refrigerating) wagons, is expanding rapidly in an effort to reduce transport costs, and it is estimated that world demands for aluminium for these purposes will rise to 70,000 tons a year, which would replace about 1,580,000 tons of steel. The analysis of demands by the road-vehicle industry suggests that this might rise to about 2·5 million tons a year: "The demand for aluminium by the industry is very unlikely to attain this figure in the near future but it can be expected to increase considerably. Looking still further ahead, the possibility of a striking growth in demand, much of it at the expense of iron and steel, can by no means be ruled out." The report also shows that there is every prospect of an increasing use of aluminium in place of steel in the superstructures of large and medium-sized ships, especially passenger vessels. At present, the total tonnage used in shipbuilding is very small (6,000 tons in 1951), but it is expected to rise to about 80,000 tons a year, mainly in the form of flat products. There appears to be a general tendency towards the increased use of aluminium in many types of semi-durable containers, and consumption may well expand from 23,000 tons to 50,000 tons, or more, in the next ten years, displacing a total of some 100,000 tons of tin-plated steel. The building and civil-engineering industry is also considered likely to grow considerably as a consumer of aluminium, in all probability at a greater rate than the volume of output of those industries.

The report's main conclusion gives food for thought for steel manufacturers: "The steel industry cannot afford to ignore aluminium as a competitor in certain fields. . . . In order to protect its position, it is necessary for the steel industry also to adopt an imaginative approach and to concentrate particularly on new designs for using smaller quantities of steel in a given structure."

British Electrical Power Convention (*continued from page* 807 *of previous volume*)

ELECTRICAL ENGINEERING IN WORLD TRADE

The afternoon meeting of the British Electrical Power Convention on Tuesday, June 15, was devoted to a consideration of a paper on "Electrical Engineering in World Trade," by Sir George Nelson. This was presented in his absence abroad by Mr. H. G. Nelson. The author said that the electricity supply and electrical manufacturing industries could make a three-fold contribution to the promotion of our export trade. First, electricity supply gave assistance to all industries, second, the electrical manufacturers made a direct contribution, and third they made an indirect contribution to many other industries, which competed in the world's markets.

The foundations of efficient production were an adequate supply of electricity and the use of the power generated to drive the most up-to-date manufacturing machinery. As pointed out in a report of the Organisation for European Economic Co-operation, the real national production of Great Britain and other European countries was higher than appeared and the internal purchasing power equivalents in European countries were from 60 to 90 per cent. greater than the exchange rates suggested. None the less, the real level of Government expenditure *per capita*, including defence, was nearly the same in this country as in the United States.

Improvement in our position as competitors for world trade could be achieved by collaboration between industry and the workers: for instance by working double, and even treble, shifts, thus lowering the cost of production of both power and manufacturing by improving the load factor.

THE GROWTH OF ELECTRICAL PRODUCTION

The contribution of electrical engineering to world trade included an extraordinarily wide range of articles; and its applications were equally versatile. It had been estimated that, measured in terms of money, electrical goods constituted about 3 per cent. of the world's trade. In 1952 the value of the world's exports was £26,500 million, of which electrical goods therefore accounted for roughly £800 million.

Information published by the Statistical Office of the United Nations showed that the production of electricity trebled between 1929 and 1950, except in Europe where it increased by an average of 167 per cent. Of the total output in 1952 about 62 per cent. came from thermal plants and 38 per cent. from water power and geothermal sources. Generating stations could rarely be sited close to load centres with which, in the case of thermal generation, the locality of coalfields might also not coincide. The essential need was to transmit large quantities of power to the load centres, a problem the difficulty of which was not likely to be decreased by the advent of atomic power stations. The introduction of the 275-kV grid was therefore a welcome development, as it would assist manufacturers to meet the demands of the export markets. As it was, there was already interdependence between the home and export markets in the case of transformers, as British manufacturers had been exporting 230-kV units for some years before the British Electricity Authority had adopted this voltage.

THE ELECTRIC TRACTION POSITION

Turning to the traction position Sir George said that on the basis of the figures given in the Cock report on railway electrification it could be estimated that it would be economic to electrify about half the lines in this country. The Ridley report and the reports of the British Electricity Authority suggested that there would be a shortage of about 20 million tons of coal per annum by 1965. General electrification would enable the coal consumption on the railways to be reduced to about 5½ million tons per annum and this would be of low grade as used in power stations. Moreover, Sir John Cockcroft had estimated that 5,000 MW of plant, the equivalent coal consumption of which was 20 million tons per annum, could be installed in nuclear power stations by 1965 or 1970.

THE DOMESTIC MARKET

One of the most significant features of post-war electrical development was the rapid growth in the manufacture of domestic appliances. In five years the output of household refrigerators had reached a total value of £60 million, of which 63 per cent. was exported. During the same period British factories had produced over 2·6 million washing machines, of which 47 per cent. had been exported. Electric cooker production had reached 1·25 million, of which 17 per cent. went abroad.

Nevertheless it had been estimated that only 12 per cent. of the wired homes in the United Kingdom contained an electric washing machine, only 18 per cent. an electric cooker and only 7 per cent. an electric refrigerator. On the other hand, in the United States 90 per cent. of the wired homes contained a refrigerator, 79 per cent. a washing machine and 26 per cent. an electric cooker. In Canada roughly 30 per cent. of the electrical households contained an electric cooker, over 50 per cent. a refrigerator and over 70 per cent. a washing machine.

In 1953 more television sets were sold in this country than electric cookers, refrigerators and washing machines combined, thus presenting a formidable competitor to those responsible for selling major load-building devices.

Finally, Sir George pointed out that the increasing complexity of modern engineering pro-

ducts was leading to a departure from the practice of obtaining each component from a different manufacturer and to a growing preference for ordering a complete project from a leading contractor. Organisations for carrying out such comprehensive contracts existed in the United States and elsewhere. If British products were to be sold to countries favouring such procedure it was essential that similar facilities should be available in this country.

DISCUSSION

The discussion on Sir George's paper was opened by Mr. D. Maxwell Buist, who said that the value of our electrical exports was £220 million last year, compared with about £233 million from America. Britain had built more hydro-electric plants overseas than any other country and its total capacity throughout the world was probably as great as that of all the water-power stations in the United States. We had more than ample capacity to meet any demand for water turbines, both at home and overseas. The "all-in" method of tendering undoubtedly had attractions for the underdeveloped countries and discussions on means of meeting it had been in progress for the past two years between the consulting engineers, the British Electrical and Allied Manufacturers' Association and the contractors.

Sir Harry Railing emphasised the interdependence of the home and export markets. No industry, he said, could plan with imagination and spend adequate sums on modernisation and research unless this were recognised.

Mr. E. C. Holroyde expressed surprise that more stress had not been laid in the paper on the importance of research. It would be necessary to devote more time and money to this activity in the future, particularly in view of the development of atomic power. Means must be found of applying the method of the "all-in" bid to the bigger jobs so as to meet American and German competition. It would remain desirable, however, for the buyers to have their independent consulting engineers to see that the work was properly carried out.

Mr. W. A. Coates said that taking the world as a whole there was no great difference between the rates of growth of hydro-electric and steam plant. The hydro-electric side might not, however, be able to maintain its position, as was shown by the way in which Canada was turning to steam plant. One of the reasons for the increase in British electrical exports during recent years had been the new markets for domestic appliances. We were now ahead again in the capital plant field and it was most important that this should provide a continuing market. As regards "all-in" bids, large companies had found that it paid them to link together for a particular negotiation and small companies might well do the same.

GENERATING CAPACITY

Sir John Hacking objected to the statement in the paper that since 1935 generating capacity in this country had been underplanned. The Central Electricity Board had looked 15 years ahead and since vesting date the British Electricity Authority had continued the same policy. This must have helped the manufacturers in their export trade. Transmission at 380 kV had first been considered ten years ago and the 275-kV grid had been designed so that the higher voltage could be used if insulator technique were improved. The economies of railway electrification seemed promising, owing to the extreme inefficiency of the steam locomotive. If, however, a more economic form of independent prime mover, such as the gas turbine, were developed it was doubtful if so good a case could be made. He thought that many of the advantages claimed for "all-in" tendering were spurious and that it was a passing fashion. The consulting engineer should continue to be completely independent.

Sir Vincent de Ferranti also thought that, while "all-in" tendering might work for a time, it would not do so in the long run. Consulting engineers must always in the end be able to give the client a better job.

Mr. V. Brain said that although Australia was free to buy in any market her generating plant was almost 100 per cent. British because on the whole it presented the best value.

Mr. H. Nimmo pointed out that the world's hydro-electric resources had probably been underestimated. Although there were great engineering difficulties in developing that power, and possibly political difficulties as well, these would be overcome and a great field provided for the British consulting engineer and manufacturer.

Mr. H. G. Nelson briefly replied to some of the points raised in the discussion.

In the evening the delegates were received in the Winter Garden by the Mayor and Mayoress of Eastbourne.

ELECTRIC LIGHTING DEVELOPMENTS

The meeting of the Convention on Wednesday morning, June 16, was devoted to a consideration of papers by Mr. W. J. Jones, on "Modern Lighting for Industry, Commerce and the Home" and on "Electricity in the Modern Home" by Dame Caroline Haslett. In Dame Caroline's absence, owing to indisposition, her paper was presented by Miss P. J. Thompson and was followed by a "forum" during which five ladies from the electrical industry answered questions upon domestic apparatus put to them by Miss Vera Norvick.

Mr. Jones began his paper by referring to the developments in electric light sources, which had taken place since the first incandescent lamp had been introduced in 1878-79 and referred to the contributions it had made to health, comfort, productivity and the national economy. Research had resulted in the production of more efficient lamps and this, combined with the continual progress in availability and the reduction in the cost of electricity, had disclosed remarkable possibilities for the future.

With the electric lamps available in 1932 only 228 candle-hours of light could be bought for a penny. To-day, using the New Warm White fluorescent lamp, 1,880 candle-hours could be obtained for the same sum. In fact, the real cost of lighting had fallen during that period to little more than a quarter for tungsten lamps and to one-fourteenth for fluorescent lamps. The improvements in fluorescent lamps had been in three directions: increased initial efficiency, longer life and higher lumen maintenance. The maximum efficiency to be expected from the present form of fluorescent lamp, giving white light of north-sky quality, was about 65 lumens per watt, while that of the so-called "Daylight" lamp was about 80 lumens per watt.

The stage had now been reached when it must be decided whether to have better colour rendering, and thus make things look as they were expected to look at the expense of efficiency, or whether future development should be solely on the basis of higher efficiencies at the expense of colour. In this connection, the two new fluorescent lamps – Deluxe Warm White and New Warm White – were interesting. The former had a colour rendering akin to that of the tungsten lamp at only two-sevenths of its running cost, while the efficiency of the 80-watt New Warm White lamp was about 4½ times that of the tungsten lamp. It would be used considerably for street lighting and in factories where the highest efficiency was desirable and colour rendering was not the prime factor.

FUTURE PROGRESS CONSIDERED

The author next discussed the requirements for lighting shops, offices, industry and domestic purposes. Before the war, during which external lighting had had to be abandoned, shopping centres in Great Britain were bright and attractive, and compared favourably with those in any part of the world. As regards the future, light must be used in new ways, of which coloured backgrounds in windows and self-luminous or illuminated unit displays were examples. Office lighting remained the Cinderella of commercial lighting, as was shown by a report in which it was pointed out that 50 per cent. of the offices surveyed had an intensity of illumination of less than 10 lumens per square foot on the desks – or only half the recommended level.

In factories, investigations had shown that higher illumination resulted in increased production, while in the home the lighting load had risen in spite of handicaps, the most important of which was that the average householder could not change his lighting at will. There was a need for more socket outlets and these should be of a type into which pendant and other fittings could be plugged, thus allowing them to be changed round at will. It was estimated that 1,000,000 householders had to reconsider their lighting each year. They should be regarded as potential increased users of electricity and every effort should be made to provide them with information on the most suitable methods to employ.

Public lighting required radical improvement and the author suggested a five-year plan whereby all existing gas street lamps should be converted to electricity and the efficiency thus raised by 200 to 300 per cent.

ELECTRICITY IN THE HOME

Dame Caroline Haslett's paper analysed some of the factors which favoured or impeded domestic electric development. In the first class were the general lifting of restrictions on production, the increase in new houses, the general levelling down of purchase tax, the increased supplies of electricity, and its cheapness, compared with the general trend of prices. On the other hand, purchase tax and hire-purchase restrictions had hampered sales, while the full range of equipment was subject to strong foreign competition. To-day, however, 82 per cent. of the houses in Great Britain were connected to Electricity Board supplies and accelerated development in the use of domestic electrical apparatus could therefore be expected. Development did not, however, end with the design and performance of apparatus. Adequate wiring and an increase in the number of plug points were essential.

After reviewing the apparatus which was available for use in the home, Dame Caroline said that the householder had now to learn that its increased use would not only cheapen electricity for industry, but aid in the production of goods for export. Householders to-day had a keen appreciation of the technical details of the equipment and the "Towards Perfection" survey of over 1,000 appliances had revealed a great measure of satisfaction with its design and performance, which was a tribute to British manufacturers. Examples showed how nearly

electricity was meeting everyday needs in different homes. At the same time, the inventive genius exhibited in so many appliances, which were standard household equipment to-day, was still at work devising improvements and extending applications for to-morrow.

The only speaker in the discussion was Mr. S. F. Steward, who suggested that the development of forceful selling methods in the supply industry had been hampered by the fact that its product was inherently superior. The demonstrations that Mr. Jones had given should show that there was no real alternative to electricity for lighting. The phenomenal development which had taken place was due to the brilliant research work of the leading manufacturers. An all-out campaign for better lighting was, however, required, because we were still suffering from the blackout years.

To be continued

RURAL ELECTRIFICATION

PRESENT POSITION AND PROSPECTS

One aspect of the policy of the British Electricity Authority is the extension of electrical supplies to rural areas. With the present demand for home-produced foodstuffs, anything that will ease the task of the producer, be he farmer, market gardener or smallholder, is worthy of consideration. Electricity, with its many and varied uses can be of great assistance to all three. In addition, the amenities offered to the country dweller by the use of electricity may have some effect in impeding the flow from country to town. Lighting, heating and cooking by electricity together with radio and television can give to the dweller in remote places many of the amenities of the town.

COST OF CONNECTION

In a booklet issued by the Electricity Authority* a critical discussion of the present position and future plans is set out. Until the Authority took over the supply industry in 1948, rural electrification was spasmodic and scattered. Although well aware of the advantages that might be gained in the long run by extension of their systems, many local concerns were not in a position to meet the very high initial outlay required. It was only when a central authority was able to spread the cost over a large area that supplies could be given to remote places at charges that were reasonable. The casual observer may wonder why connection charges are high even when a transmission line passes over the area; if this happens to be one of the main high-tension lines of the grid system, connection to it would require a local substation, which would be costly, and might be technically inadvisable. The cheapest practicable connection would cost at least £200,000 in the case of a 132-kV line. It would be less for the 66-kV and 33-kV lines but the operational flexibility of them might be seriously impaired. Only when the distribution lines are at 11-kV or less can the potential revenue be at all commensurate with the cost of making the connection.

In any event, in scattered districts, the potential revenue for each mile of line can never be great, and the farther the electrification proceeds, the fewer will be the possible users. Consequently, as there is a limit to the use of capital which can have very little return, it is still necessary to require consumers to make some contribution towards the cost of connection. Naturally, the greater the consumption of each connection, the greater will be the total return, and connection charges can then be decreased. The contribution may take the form of a minimum revenue guarantee, a line rental, a capital payment or a combination of all three. In some cases tax relief can be obtained, and in others Government grants may be available.

GROWTH IN THE PAST

When the first conference on rural electrification was held in 1926, there were only 1,770 farms taking a supply and the average consumption of each was about 1,150 units a year. At that time, further electrification was considered impractical on economic grounds. Between 1929 and 1931, a few schemes were carried out, under Government sponsorship and with financial assistance, mainly in order to test the demand; some schemes were also completed by a few of the larger undertakings, without outside assistance. In the following years, progress continued, but very slowly, and the average consumption had risen to 1,400 units a year by 1935. On April 1, 1948, when the central Authority took over, it was estimated that 85,600 farms had supplies. This was about 30 per cent. of the farms in the areas covered by the Boards. At the same date about 55 per cent. of the 2,000,000 houses in rural areas were also connected. (These figures of course refer to mains supplies and do not include private generating plants.)

In the Electricity Act of 1947, the Boards are specifically charged with the duty of extending supplies to rural areas as far as may be practicable. The task was made easier as the whole industry was now integrated and interlocking schemes could be planned. Progress in electrification had not been greatly hampered by wartime restrictions, as food production was high priority, but the new Authority was faced with a shortage of generating capacity owing to lack of construction during the war years, and by the severe post-war limitations in capital investment. The position has since been eased in both directions. In spite of these limitations, the Area Boards made connections to another 49,000 farms between April, 1948, and March, 1953, or nearly 10,000 a year a figure which compares very favourably with the 4,000 added in 1938, the last full year before the war. The rate was increased during 1953-4 and by March 31, 1954, the total had risen to over 60,000. Capital expended on these extensions (quite apart from new generating plant) amounted to approximately £6 million a year.

CONSUMPTION TO-DAY

Although individual consumption has increased steadily, reaching an average of 5,000 units a year in 1952, it is estimated that, on a typical mixed farm, the annual consumption could easily be three times as great. This is the figure that has been estimated for a farm keeping 20 milch cows, as well as pigs, poultry and crop-growing, and some grain and grass drying. Possibly the dairy offers the greatest single field for electrification, with its milking, chilling, sterilising and bottling machines, but there are many other applications where electricity can provide heat, light and power. Even the electrified fence offers a saving for the user. Advice and help for farmers wishing to extend their use of electricity are offered by the National Farmers' Union, the Area Electricity Boards, the British Electrical Development Association, the British Electrical and Allied Industries Research Association, and other bodies. The horticulturist, too, has scope for electricity for pumping, soil sterilisation, heating and other purposes.

PROSPECTS FOR EXTENSION

In June, 1953, the House of Commons passed a resolution that "steps be taken to develop the supply of electricity in rural areas as much and as fast as possible." This has enabled the Authority to make future plans which are reasonably free from restrictions. However, there are three basic considerations which must guide any capital outlay. Firstly, the industry is required to preserve the balance of its accounts, taking one year with another – that is, it must pay its way; secondly, the whole cost of electrification must be borne by its own resources – and loans must be at market rates; and thirdly, although restrictions on rural electrification have been eased, the total amount of capital that can be invested is still limited. Over the next five years, an expenditure of £50 million for rural areas is estimated. This will mean that by 1958, 200,000 farms and 1,700,000 dwellings will have supplies available. Another £50 million will be spent between 1958 and 1963, making supplies available to 45,000 more farms. This will mean electricity for 85 per cent. of all farms and over 80 per cent. of all houses in rural areas. The remainder, being very isolated, will require special consideration.

Because the countryman tends to use electricity at times other than those when the industrial loads reach their peak, a rural community gives assistance in load-balancing; that is, it tends to even out the total demand for electricity and means that generating plant can be run more economically. Thus a higher revenue can be obtained from a given capital outlay. But the cost of connection remains high and so only by using supplies to the full can the electrification of remote areas be made economic.

* Rural Electrification: progress and policy. British Electricity Authority, Winsley-street, London W.1.

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QUALITY OF CARBURISING ATMOSPHERES

An instrument for measuring the quality of a carburising atmosphere has been developed by the General Electric Company, Limited, Magnet House, Kingsway, London, W.C.2. It consists essentially of a compartment (with a transparent front) containing an iron wire which is carburised in the atmosphere under test and cooled rapidly so that it is transformed to martensite. In this condition the electrical resistance of the wire is a measure of its carbon content and hence of the carburising potential of the atmosphere. Values of the electrical resistance of the quenched wire can be directly related to carburising potential from a calibration curve. Operation of the gauge is straightforward and one measurement takes about 15 min.

The potential measured on the gauge is the carbon content of a steel with which the atmosphere would be in equilibrium at a given temperature. For example, if the carburising potential of an atmosphere is measured on the gauge as 0·65C, then this atmosphere would be neutral to a 0·65C steel. This method of evaluating the quality of a controlled atmosphere is particularly useful in such processes as the hardening of medium or high carbon steel where decarburisation is to be avoided, the restoration of carbon to surfaces of parts which have been decarburised during casting or heat treatment, and the carburisation of steel to some specific value of carbon content.

The instrument can be supplied as a panel-mounted carbon gauge or, when the instrument is required for use on several furnaces, it can be supplied as a portable unit. For measuring the resistance of the gauge wire after carburising, the voltage developed across it is measured for a small known value of current. The carburising potential of the gas can then be read off from the calibration chart.

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A 100-KV DIRECT-CURRENT CABLE: ERRATUM

We regret that on page 715 of our previous volume in the paper on "A 100-kV Direct-Current Cable," which was read by Messrs. B. Bjurstrom and R. Johansson before the recent CIGRE meeting, it was stated that polythene was used as an insulating material. We are informed that the risk of using this insulant was considered to be too great and that, in fact, a very dense paper applied under considerable stress was employed.

COAL UTILISATION RESEARCH

Among the projects carried out by the British Coal Utilisation Research Association, Randalls-road, Leatherhead, Surrey, and described in their annual report for 1953, issued recently, may be mentioned the formation of a field research unit on boiler-operating conditions. This unit serves the dual function of exploring differences between practices in factories and in the research laboratory at Leatherhead, and of providing a service to member firms. It has, for example, been able to solve the problem of high side-flue temperatures in several recently-installed Lancashire boilers, by recommending the cleaning of dust-laden furnace tubes and the installation of furnace-tube baffles. Such baffles, designed to obstruct the top half of the furnace tube, cause a change of gas flow which tends to keep the bottom of the furnace tube free from loose dust accumulations; they also give an appreciably higher efficiency in a clean furnace.

In the laboratory, as part of a study of the burning of coal in boiler grates, a coking stoker has been substituted for the chain-grate stoker, on which investigations have been completed. A combustion pot is used for forecasting optimum burning rate and moisture content for the various coals selected; experience has shown that the combustion pot burns coal with more control and with less air than the full-scale mechanical stoker, and suggests that better combustion is secured when burning rates are high. The laboratory's main central-heating boiler has therefore been equipped with mechanical stokers having a substandard grate area, to investigate the value of high rates of combustion. Experiments have also been initiated on assessing the behaviour of coals with underfeed screw feeding, and for this purpose a small commercial stoker has been installed, equipped with instruments to measure burning rates, flue-gas analysis, etc.

SUCTION PYROMETER OF HIGH ACCURACY

Studies of heat transfer, directed to obtaining boiler-design data, have been continued and experiments have been carried out on the Economic boiler in an attempt to obtain a better correlation between theory and industrial practice. One cause of discrepancies has been found to be the uncertainty of the true gas temperature at the inlet to a smoke tube. For such studies, a suction pyrometer, accurate to within 1 per cent., and suitable for temperatures up to 2600 deg. F. when provided with a refractory head, has been developed in collaboration with a member firm, and is now available commercially. A total heat meter, less accurate than the suction pyrometer over the same temperature range, but useful at temperatures above 2,600 deg. F., has also been developed. Still under development is a pneumatic pyrometer utilising the change in density of a gas with variations in temperature.

CYCLONE COMBUSTOR FOR SOLID-FUEL TURBINE

As part of a D.S.I.R. programme on solid-fuel firing for gas turbines, work has continued on a slagging cyclone combustor for burning fine, but not pulverised, high-ash coal. Slag accumulations on the walls near the inlet points has been overcome, and further adjustments to the airflow to reduce the ash settling on the crown surface are now in progress. Preliminary investigations have been made to determine the behaviour of several other coals than the Cronton smalls which have been used in most of the experiments.

For cleaning hot gases, for use with gas turbines, a collector has been developed, having a long narrow tangential entry with outlets at both ends, and " blow downs " for the collected dust, also at both ends. This has given higher collection efficiencies than the vane-entry collector previously studied. In the light of the Association's experience, a member firm has built an experimental slagging-cyclone combustor, which is to be run, at about 4·7 atmospheres, with a gas turbine of about 2,000 kW output.

In the course of investigations into gas-producer practice, the importance of the depth of fuel bed to the quality of gas has been demonstrated, as has also the feasibility of working at a higher pressure. In collaboration with a member firm, automatic control gear for the coal-feed to the producer has been developed, and is being used increasingly in the glass and steel industries.

INDUSTRIAL POSSIBILITIES OF SLURRY-PELLETING

A plant has been developed for pelleting slurries for feeding to a gas producer, and a wide selection of colliery slurries have been used, from which it appears that all slurries are capable of being pelleted. At the request of the British Iron and Steel Research Association, pelleting tests have also been carried out on a variety of iron-ore fines, as possible feed to ore-sinter plants. Pellets have also been made from fly ash for a firm of mushroom growers.

SIZING DUST PARTICLES

Work has continued on the assessment of dust in combustion gases, and, using a cyclone probe already developed, it has been shown that current methods of dust sampling at several power stations may be in error by up to 5 or 10 per cent. A code of procedure for sampling is under discussion. In conjunction with a member firm, a machine capable of microscopically sizing dust automatically, down to sizes of the order of 5 microns, is under development. For sizing dust still in the airborne state, centrifugal elutriation has been investigated, and a new instrument in which the dusty gas is fed between two parallel spinning plates to a central offtake has given promising results.

Other industrial research work include studies on the combustion of coal volatiles, field and laboratory studies on boiler deposits and corrosion, and chemical studies on coal to determine whether complex chemicals not easily produced from petroleum may be made available to industry.

During 1953, a new domestic appliances building was opened, and one of the chief projects of this laboratory is the development of more realistic methods of assessing these appliances. Laboratory studies are therefore being reinforced by field trials under normal household conditions. Regarding the problem of smoke reduction, fundamental studies are still at an early stage and " the best hope of reducing smoke from open grates lies in the use of smokeless fuels."

THE NATIONAL INSTITUTE OF AGRICULTURAL ENGINEERING

In the article on the open days of the National Institute of Agricultural Engineering in our issue of June 4 (page 708 of our previous volume), details were given of an experimental tractor with a hydraulic transmission. This machine is a good example of the fundamental research that the mechanical engineering section of the Institute carries out. There were, however, other experimental machines on view of not quite such a fundamental nature but which had been designed for a specific purpose. One of these, namely a ditch cleaner, is illustrated in Fig. 1, opposite. This has been developed to fill the gap between hand labour and costly excavating machinery, and is designed for the maintenance of ditches up to 4 ft. 6 in. wide and 3 ft. deep.

The action of the cleaner is nearly analogous to that of a milling cutter, the cutting head in this case being fitted to the end of an outrigger which, in turn, is anchored to the frame of a standard tractor. The outrigger is raised and lowered by means of a hydraulic ram situated below the belly of the tractor and the cutting head is driven from the tractor rear power take-off, the transmission group consisting of a chain and sprocket assembly which transmits the drive to a bevel gearbox at the base of the outrigger and a propeller shaft which connects the bevel box to the cutter head. The propeller shaft is of particular interest as it has been designed to reduce friction between the telescopic portions to a minimum thereby eliminating " binding " between these two parts. The shaft is, of course, fitted with universal joints in the normal manner.

The cutting head consists of a circular disc fitted with a series of cutters the final form of which has yet to be determined. The disc is set at an angle to the direction of motion in much the same manner as on a disc-type plough and the direction of rotation is such that the spoil is thrown in front of the arm towards the tractor: this is essential so as to permit the machine to clean ditches running beside hedges. Furthermore, the action of the disc ensures that the spoil is broadcast over the area of the field adjacent to the ditch so as to prevent the formation of ridges. The depth of cut is regulated by tandem land-wheels situated immediately in front of the disc and arranged to run along the bottom of the ditch, the height of the wheels in relation to the bottom of the disc being adjustable. It will be appreciated from this rather brief and general description of the machine that the design is fundamentally simple, and that the first cost, therefore, should be reasonable. Furthermore, it can be used with any tractor of the requisite power, such as the Fordson Major and operated in almost any location which gives access to the tractor. There would appear to be very little doubt as to its efficacy as during the open days it was employed with complete success in cutting ditches from what was tantamount to virgin soil.

POTATO HARVESTING MACHINE

Another good example of a machine developed for a specific purpose is furnished by the potato harvester shown in Fig. 2, opposite. It has been developed to fill the gap between diggers and complete harvesters and with this object in view, has been designed in three separate parts, namely: a digger and separating spider; an elevator; and a picking conveyor. These parts can be used either separately or together and once a farmer has purchased the basic digger, he can add the elevator and picking unit at a later date. Simplicity coupled with efficiency have formed the basic requirements of the design. The digging unit consists of a disc-type share set to deliver the raised crop on to a spider fitted with a haulm separating roller. On leaving the spider, the potatoes pass to an endless-belt elevator

which, in turn, delivers them to the picking unit. This consists of a slotted-type conveyor disposed on a framework fitted alongside the tractor and arranged to accommodate from three to four operators, the overhanging structure thus formed being supported by a separate landwheel. The picking unit, however, is designed so that, if required, it can be mounted on a trailer drawn alongside the tractor and there is no reason why it should not be used in a stationary role. The complete harvester has had extensive use and detailed modifications made as the result of experience gained in the field have led to the evolution of a remarkably efficient machine.

Fig. 1 Experimental ditch cleaner. The cutting head is driven from the tractor rear power take-off and the depth of cut is determined by the tandem wheels in front of the cutting disc. A boom anchored to the side of the tractor supports the cutter head, the boom being raised and lowered hydraulically.

FIELD INVESTIGATIONS

The work of the Institute is by no means confined to the development of new machines. Considerable attention, for example, is paid to techniques so as to establish whether traditional methods are, after all, the best or whether some new process really possesses the advantages claimed for it. In this connection, considerable work was carried out to establish whether the crushing of grass after cutting really did accelerate the making of hay. A pick-up roller crusher of the type shown in Fig. 3 below, and a flail-type of cracker were used for these investigations and it was eventually established that although under ideal conditions crushing the crop immediately after cutting did accelerate slightly the drying rate, the crushed crop was more vulnerable to re-wetting by rain. As a result of these tests, it is most unlikely that this process will gain favour in the United Kingdom where the cut crop is more than likely to be subjected to several re-wettings. It should be emphasised, however, that crushing can prove of real value in countries such as America and Canada where more settled weather can be expected.

MEASUREMENTS

Nearly all the investigations carried out by the Institute involve measurements of some kind or another and in order to emphasise this interrelation between research and measurement, the laboratories which specialise in this aspect of the work staged demonstrations during the open days which showed off the special techniques involved. Lack of space prevents a detailed description of these exhibits from being given, but it was very obvious from a brief examination that much ingenuity has been used to produce relatively cheap but efficient instruments by modifying and adapting standard units. An optical projector, for example, had been made from an ordinary photometer bench. Much use is made at the Institute of electrical strain gauges for carrying out such work as the determination of the stresses in plough beams, tractor linkages, etc., and the instruments on view included four-channel and eight-channel strain recording equipments. A particularly interesting device has been developed to allow shaft speeds to be recorded by these equipments, the requirement for this coming from the tractor-testing section who wished to study the behaviour of governor mechanisms under rapidly changing loads. The apparatus consists basically of a tachometer generator feeding into a unit which converts the direct-current voltage of the generator into a signal which the recording equipments can amplify and record. The device has proved outstandingly successful and has been used for a wide variety of purposes including engine speed records for an engine manufacturing company. A particular feature of the apparatus is that the mean value of the shaft speed can be "backed off" and the sensitivity altered at will to give a full scale linear deflection varying from $\pm$ 1,500 r.p.m. to $\pm$ 50 r.p.m. With a mean speed of 1,000 r.p.m. full scale deflection can be made, therefore, to represent a change in speed of $\pm$ 5 per cent. and any range of speed can be recorded directly up to a maximum of approximately 3,000 r.p.m.

DRYING, HANDLING AND STORAGE OF GRAIN

The grain section has been carrying out a considerable amount of work on the drying, handling and storage of grain and the exhibits of this section included four cylindrical outdoor type silos. These are constructed from galvanised steel, aluminium, plywood and concrete and are being used for grain storage experiments. For studying the behaviour of ventilated silos out-of-doors, a rectangular brick silo with a perforated aluminium floor has been constructed and is being used in conjunction with an experimental warm-air ventilating equipment. Other work being carried out by this section includes the development of a simple design of cleaner, research into the behaviour of grain in oscillating trays and conveyors and experimental work on a combustion system.

The foregoing brief description by no means covers the complete range of equipment, etc., on view during the open days. Much of this, however, has already been described in connection with reports on previous open days and notably by Mr. W. H. Cashmore, B.A., M.I.B.A.E., Director of the Institute, in a paper* read before the Institution of British Agricultural Engineers in London on February 24, 1953.

* ENGINEERING, Vol. 175 page 414 (1953).

Fig. 2 Prototype potato harvester. This machine has been developed to fill the gap between diggers and complete harvesters and consists of three separate parts, namely: digger and separator; an elevator; and a picking conveyor. The digging and separating unit can be used alone.

Fig. 3 Pick-up crushing rolls of the type used for investigating the effect of grass crushing on hay making. It was established that although under ideal conditions crushing did accelerate slightly the drying rate, the crushed crop was rendered more vulnerable to rain.

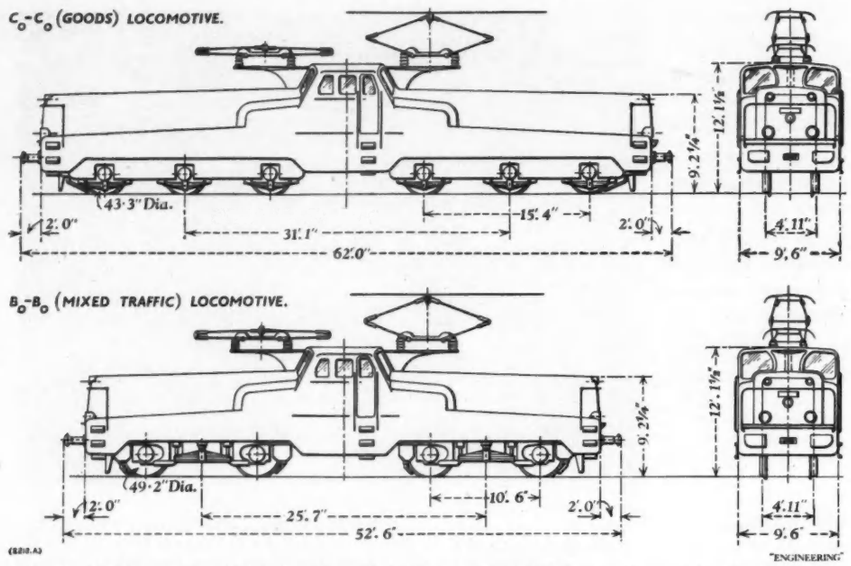

Fig. 1 Outlines of the C_0-C_0 (goods) and B_0-B_0 (mixed traffic) locomotives. The single cab is a departure from French standard practice.

ELECTRIC LOCOMOTIVES*

For motive power on the Valenciennes-Thionville line, the Société Nationale des Chemins de Fer Français has ordered 105 electric locomotives; 85 of them of the C_0-C_0 type and the remainder B_0-B_0. Four different methods are employed in these locomotives for electrical conversion between the 22,500-volt single-phase 50-cycle overhead wire and the driving motors. The line is 170 miles long and has gradients up to 1 in 87 – one section has this gradient for 11 miles. Heavy mineral trains form a large portion of the traffic. These will be handled mainly by the C_0-C_0 locomotives which are designed to haul goods trains of 1,800 tons on gradients of 1 in 100 or of 2,400 tons on gradients of 1 in 166. Their maximum speed is about 37 m.p.h. The B_0-B_0 locomotives are for mixed traffic work and have maximum speeds of 65 and 75 m.p.h. according to type.

A departure from French standard practice is that these locomotives have only one, centrally placed, driving cab. The reduction in components and fittings resulting from this gives an estimated saving of about 8 per cent. in cost. Also, since all equipment is grouped fairly closely together, remote control systems have been omitted and direct manual control with mechanical interlocks substituted. It is hoped that this change will reduce the risk of electrical failures, which, according to an analysis, account for about half the total number of breakdowns. Although by this arrangement more work is thrown on the drivers, it is considered that their skill is quite equal to the demand. In any case, the physical labour involved is much less than is required with steam locomotives. Additional advantages are claimed for construction, as the equipment is only covered by light hoods and a considerable degree of prefabrication is possible. The underframe is designed to take all buffing and shock loads.

One difficulty encountered with a single cab is the obstruction of visibility by the pantographs. This has been overcome in these locomotives by mounting them on cantilevers projecting from the cab, and keeping them as close together as other considerations permit. The final distance chosen between centre lines was 15 ft. 9 in. Under these conditions, the driver can see running signals for a period of 16·1 seconds when the locomotive is rounding a curve of 550-yd. radius at the maximum permitted speed. The regulation minimum period of visibility is 10 seconds. Visibility of ground signals, and during shunting, is quite satisfactory.

It has been claimed that maintenance costs would be higher with a 50-cycle system than when using 16⅔ cycles. Analysis of annual costs of a 1,500-volt 2D2 locomotive and one of the B_0-B_0's shows that the difference is slight and should not be regarded as a predominant factor in determining electrification costs. With the new locomotives, the position of the equipment should allow most overhauls and repairs to be carried out *in situ*, and without dismantling.

To avoid difficulties with spare parts, as many items as possible on all four types have been standardised. Almost all auxiliary equipment has been made standard, including a large number of the components of the traction motors, converters and transformers, although these have been designed by various makers. Outlines of the two types of locomotive, with their principal dimensions, are given in Fig. 1.

* "Electric Locomotives on the Valenciennes–Thionville Line." By F. Nouvion. Paper presented to the Institution of Electrical Engineers on May 6, 1954. Abridged.

THE C_0-C_0 LOCOMOTIVES

As the maximum speed of the C_0-C_0 locomotives has been limited to 37 m.p.h., a comparatively simple design of suspension has been possible. To obtain good weight transfer the system used in the Alsthom C_0-C_0 direct-current express locomotives has been adopted. In this, the superstructure is carried on each bogie by two rigid longitudinally-spaced supports – an arrangement claimed to give adhesion qualities equal to six axles on a single rigid frame. The traction motors are nose-suspended on the bogie transom and drive through double-reduction gears, the gearbox being hung from the axle by suspension bearings. The gross weight of the locomotives is 120 tons.

The two types of electrical system used in the C_0-C_0 locomotives are: single-phase/direct-current rotary-conversion and single-phase/three-phase generation with variable frequency. In both types, synchronous driving motors are used, chosen mainly because they allow operation at unity power factor. As the efficiency of locomotives using rotary converters is reasonably good when running near full load, the power has been kept low to achieve this in general practice. It has been shown that the energy consumption of a locomotive fitted with a rotary converter and using 50-cycle regenerative braking is 25·2 Wh per ton mile as compared to 34 Wh per ton mile for one working on 16⅔ cycles, both figures being gross values.

ROTARY CONVERSION TO D.C.

The C_0-C_0 locomotives, using single-phase/direct-current generators, of which there are to be 65, have a 2,900-h.p. 3,000-volt synchronous motor running at 1,500 r.p.m. and are fitted with two direct-current generators, each of which feeds three traction motors. Fig. 2 is the circuit diagram. For starting, the Arno set drives an exciter, which operates as a decompounded generator and supplies one of the main generators. This runs the main set almost up to full speed when the synchronous motor is automatically connected to the transformer, first at half voltage and then, when synchronism has been reached, to full voltage. The system is fully protected and the direct-current generators are of the type having limited current and power output. Field control is by the opposed-shunt system which, by careful selection of the excitation, enables running at practically constant power output to be attained automatically.

The total weight of these locomotives, 120 tons, is made up of 71 tons of mechanical components, 45·3 tons of electrical equipment and 3·7 tons of ballast. Of the electrical gear, the rotary converter weighs 20·8 tons, the transformer 6, and the six traction motors together 9·9 tons (not including gears). With a train of 1,800

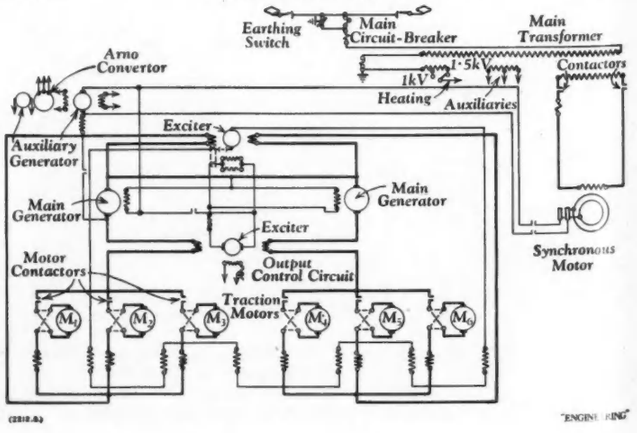

Fig. 2 Circuit diagram for C_0-C_0 locomotives with single-phase/direct-current rotary conversion.

tons, the average speed over the 170 miles was 29 m.p.h. No undue heating of the motors has been found even on the 11-mile stretch at 1 in 87. The power rating is 2,490 h.p. at 17·4 m.p.h.

THREE-PHASE VARIABLE FREQUENCY

The second type of conversion used with C_0-C_0 locomotives is from single phase to three phase. The continuous power rating of this type is 3,590 h.p. at 24 m.p.h. and 20 are being built. The driving unit consists of a synchronous motor, a six-pole rotary phase-converter running at 1,000 r.p.m. and an eight-pole frequency converter with a speed range from − 750 to + 1,280 r.p.m., a corresponding frequency range from 0 to 135 cycles and a voltage range from 0 to 1,300 volts. The circuit diagram is given in Fig. 3. The first set consists of the phase converter and a direct-current generator keyed to the same shaft. The second is a direct-current motor and a frequency converter, also keyed together. This enables the rotor of the frequency converter to be driven at variable speeds for supplying the six three-phase asynchronous squirrel-cage traction motors.

Starting is carried out in a similar manner as for the single-phase direct-current locomotives. It is expected that these locomotives will have excellent adhesion qualities as the axles are electrically coupled. However, to avoid overloading any traction motor during running, it is essential that the diameters of the wheels should be as nearly the same as possible. In these locomotives the electrical equipment accounts for 55 tons of the total weight of 120 tons. Although this type is more powerful, the tractive efforts are identical since the reference speed is higher. The maximum speed is the same.

THE B_0-B_0 LOCOMOTIVES

Of the 20 B_0-B_0 mixed-traffic locomotives, 15 will be driven by single-phase motors connected in parallel. The continuous power rating is 2,720 h.p. at 33 m.p.h. and the maximum speed has been fixed at 65 m.p.h. The four 18-pole motors are supplied from one transformer and voltage regulation is carried out on the primary side owing to the large secondary current of approximately 12 kA. Manual control is employed.

The motors differ somewhat from standard European design in the precautions taken for cooling. There is no compensating winding but interpoles are used working with a resistor-capacitor shunt. This enables the transformation e.m.f. to be neutralised at both high and low speeds, and also gives an improved power factor. An automatic device short circuits the capacitors when a pre-determined speed has been reached. On test, these motors withstood 1·5 times the one-hour rating current for 30 seconds while at a standstill, and experience in the Belgian Congo has shown no abnormal brush wear. They will also withstand starting the locomotive at the very low acceleration of 0·066 ft. per sec. per sec. Fig. 4 is the circuit diagram.

The gross weight of these locomotives is 80 tons of which mechanical components account for 44. The transformer and voltage regulators weigh 10·9 tons, the four motors 16 tons, and the inter-pole shunt device 2 tons. The specification requires trains of 750, 900 and 1,300 tons to be started and hauled at 33 m.p.h. on gradients of 1 in 100, 125 and 200, respectively. For passenger working, the maximum speed should be obtained when hauling a train of 900 tons on the level; with a train of 750 tons, the journey would take 3 hr. 16 min. (including stops).

IGNITRON CONVERSION

The remaining five B_0-B_0 locomotives are to be fitted with ignitron conversion. The continuous rating is 3,260 h.p. at 33·5 m.p.h., and with a continuous-rating tractive effort of 16 tons they will be the most powerful French locomotives of their class. The circuit diagram is given in Fig. 5. The four traction motors are connected in parallel, each being fed from two ignitrons. Voltage control is by a regulator similar to that used for the single-phase motors, and, like it, is on the high-voltage side of the main transformer. Owing to the steep traction-effort/speed characteristics, however, intermediate notches were required. The six-pole traction motors are a standard type, uncompensated, and the excitation ampere-turns can be reduced to 50 per cent. of maximum excitation. Manual control will be employed generally.

The eight ignitrons are water cooled and have continous ratings of 475 amperes at 750 volts. Guaranteed overloads are 150 per cent. of rated load for 2 hours and 300 per cent. for 1 minute. The water coolers are arranged laterally in the superstructure and are ventilated by the same fans that cool the motors. The electrical layout resembles that used on the Pennsylvania Railroad. Of the total designed weight of 83 tons the electrical equipment accounts for 39·5 tons. The maximum speed has been fixed at 74·5 m.p.h., and the required performance is the same as for the B_0-B_0 locomotives with single-phase motors.

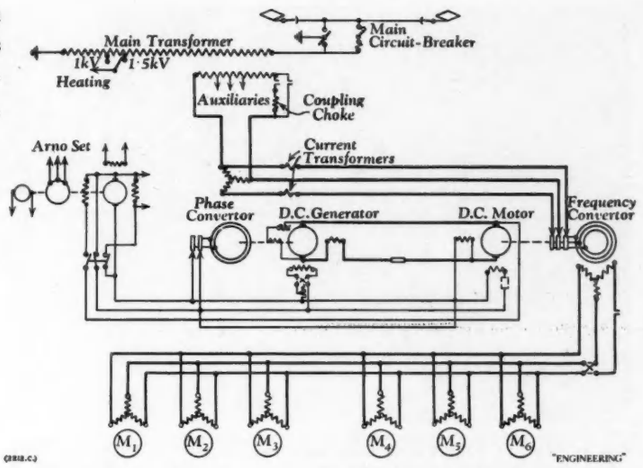

Fig. 3 Circuit diagram for C_0-C_0 locomotives with single-phase/three-phase rotary conversion.

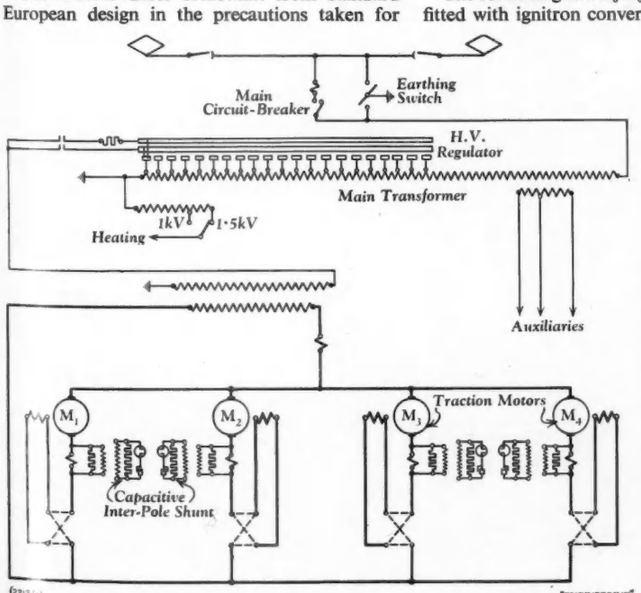

Fig. 4 Circuit diagram for B_0-B_0 locomotives with single-phase/single-phase transformation.

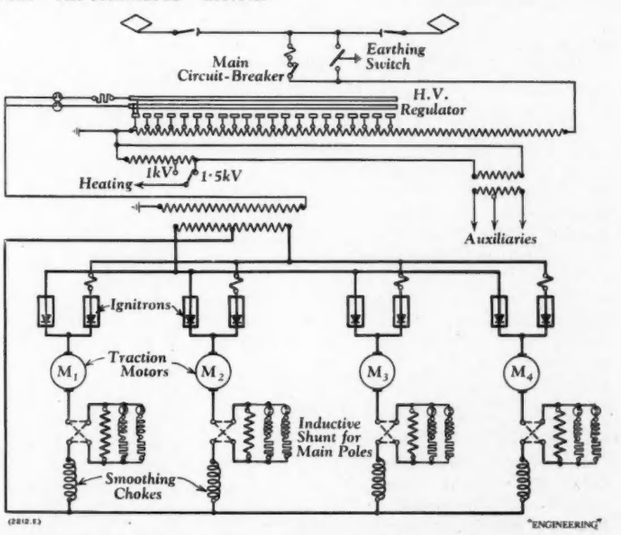

Fig. 5 Circuit diagram for B_0-B_0 locomotives with ignitron conversion. As with the single-phase locomotives, voltage regulation is on the primary side, but intermediate steps were required owing to the traction effort/speed characteristics.

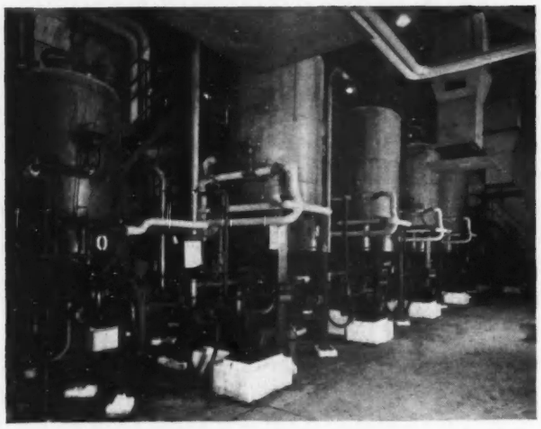

Fig. 1 Stills in which the varnishes are blended for the synthetic resins with which the paper and fabric fibres are impregnated.

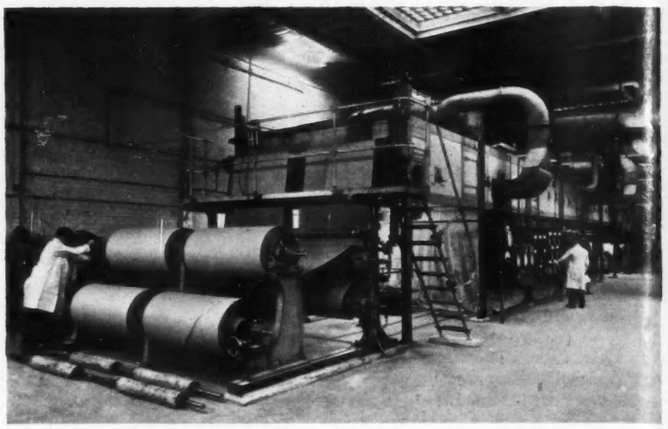

Fig. 2 Mitchell horizontal impregnating and drying machine, in which two rolls of paper can be impregnated and dried simultaneously.

MAKING LAMINATED PLASTICS

DE LA RUE FACTORY AT TYNEMOUTH

Representatives of the technical Press were recently given the opportunity of viewing the Tynemouth factory of Thomas de la Rue and Company, Limited, (Plastics Division), Imperial House, Regent-street, London, W.1. The factory is concerned principally with the manufacture of laminated plastics: Formica, a hard chemically-inert decorative laminate for domestic, industrial and hospital use, is proof against stains and moisture, and resistant to abrasion and temperatures up to 266 deg. F; Traffolyte, a less expensive, easily cleaned decorative laminate, but with a lower resistance to abrasion, is widely used for ceilings in British Railways rolling stock, and is also supplied with different-coloured layers for engraving.

Delaron, an industrial laminate, is made in two forms: a paper-based material, which can be readily fabricated, extensively employed for electrically insulating boards and components, particularly in the radio and electronics industries, and available in eight grades suited to a variety of purposes; secondly, a fabric-based material, with self-lubricating properties, mechanically strong and able to resist wear.

The method of manufacture of all these laminated plastics is similar; rolls of paper, or fabric, are passed through synthetic resin baths, dried in an oven, then cut to size and formed into packs which are placed between polished-steel sheets and formed in heated hydraulic presses. The properties of the resulting laminate are determined by the composition of the resin, the speed and temperature of impregnating, and the forming time and temperature.

Most of the resins are blended in the factory, in the Fraser stills shown in Fig. 1. The varnishes, of which some 60 different grades are used, are stored in outside tanks and conveyed by pipeline to the stills In the case of printed decorative laminates, the pattern is applied to the base paper by normal photogravure machines.

IMPREGNATING AND DRYING

In the heating bay where the paper is impregnated, there are a variety of horizontal and vertical impregnating and drying machines, the largest of which is illustrated in Fig. 2. This machine, constructed by Mitchell Engineering, Limited, Peterborough, to the company's specification, can treat two rolls simultaneously and has a maximum throughput rate of 150 ft. per minute; in the illustration the treated core material can be seen emerging from the 100-ft. hot-air drying oven, the temperature of which is automatically controlled. Core materials are also treated on vertical machines, supplied by the General Engineering Company, Limited, 9 Bury-road, Radcliffe, Lancashire, which again employ hot-air drying. In another machine utilising an infra-red oven, are treated the overlays for providing the top surface of Formica sheeting, in effect a transparent layer highly saturated with hard-wearing resin. While the paper or fabric is being processed, tests are made at frequent intervals.

WATER-HEATED PLATENS

After cutting to size, the sheets are inspected and undergo further drying in a room which is maintained at constant temperature and humidity. Packs, comprising six to ten core sheets, with a decorative surface sheet and overlay are then built up by placing them in contact with highly-polished steel plates ready for hot-forming in Shaw presses, the heat for which is supplied from a high-pressure hot-water system.

Fig. 3 General view of the press shop, where packs of impregnated paper are pressed between mirror-polished steel plates in heated platens.

The larger presses – one 5,000-ton 9-ft. by 4-ft. daylight press, and two 4,150-ton 8-ft. by 4-ft. presses – are fed by preloaders, as may be seen in Fig. 3. In the press, a pressure of about 1 ton per square inch is maintained for about 1½ hours while the platens are heated to 150 deg. C. The temperature is maintained for a specified period, after which the platens are water-cooled. When sufficiently cool, the formed plastic boards are removed from the press and are ready for separation from the steel sheets.

After separation, the boards are transferred to the trimming shop where the edges are trimmed by powered saws and the back surfaces are sanded to provide a key for gluing. The highly-glossy surface resulting from contact with the mirror-steel plates is generally toned down to a matt finish in a revolving-brush machine. A grading inspection follows, and sample strips from each board are tested in the laboratory. For industrial laminates, these checks are particularly rigorous so that they conform fully to specification.

EXTRUDED POLYTHENE PIPING

In addition to the manufacture of plastic laminates, a certain amount of thermoplastic extrusion work is carried out at Tynemouth, on cellulose acetate, polyvinyl chloride, and polythene. One of the most interesting developments in this field is extruded polythene piping for cold-water plumbing, a system which has been adopted by the National Coal Board and has already been installed in two mines. The polythene piping is light and easy to handle, is chemically inert, and, with good heat-insulating characteristics, withstands the effects of frost.

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ELECTRICITY SUPPLY IN MAY

Substantial Increase Recorded

During May, 1954, 5,053 million kWh were sold by the British Electricity Authority. This is an increase of 14·8 per cent. over the figure for May, 1953. When corrected for the weather and the number of working days, the figure is reduced to 9·6 per cent., the weather having been considerably colder than twelve months previously and the number of working days less. The amount of electricity sent out by the Area Boards was also 5,053 million kWh. Supplies to the "mainly industrial" areas increased by 14·1 per cent. and to the "mainly non-industrial" areas by 15·9 per cent.

FLUID VALVE WITH MECHANICALLY-ROTATED PLUG

MOTOR AND MANUALLY OPERATED VERSIONS

A mechanically-operated hydraulic valve designed to provide ease of action, unobstructed flow and effective surge control has been developed for use in hydro-electric plant, trunk mains, water works and numerous other installations involving the transport of fluids. Known as the "Rotovalve," it is made in this country, under licence from the S. Morgan Smith Company, York, Pennsylvania, U.S.A., by the Harland Engineering Company, Limited, B.E.P. Works, Alloa, Scotland, and production of a range of standard sizes up to 72 in. in diameter has recently begun. To extend its field of application, various forms of operating and automatic control equipment can be fitted to the valve, and versions operated by hand, electric motor and hydraulic or pneumatic servo-mechanisms are built.

The design of the Rotovalve is similar to that of a plug cock but differs both in the operating mechanism, which takes the same form whatever the driving unit, and in the method of seating. The raised annular seating surfaces, which can be seen in Fig. 1, provide the sole contact between the plug and the valve body and consist of Monel-metal flats fused to the parent metal of each of the two components. The flats are located in such a way that seating only occurs when the valve is fully opened or closed.

FRICTION-FREE ROTATION OF PLUG IN VALVE BODY

The body is slightly tapered internally to receive the plug, which is of conical shape. The operating mechanism rotates the plug about its axis for opening and closing and during the turn through 90 deg. there is no direct contact between body and plug. Consequently there is no heavy face-to-face friction and the torque required to rotate the plug is comparatively small. Moreover, the arrangement of the seating is such that a self-cleaning action automatically takes place when the valve is operated.

The ports in both components are circular and correspond to close limits when aligned; consequently, when the valve is fully open there is unimpeded flow from flange to flange and the loss of head is equivalent to that in a straight pipe of the same bore and length. Moreover, when the valve is in this position the valve seats are not exposed to the direct action of the fluid, and pitting, erosion and wire drawing can only occur during the brief periods of opening and closing. Emergency seals are therefore unnecessary.

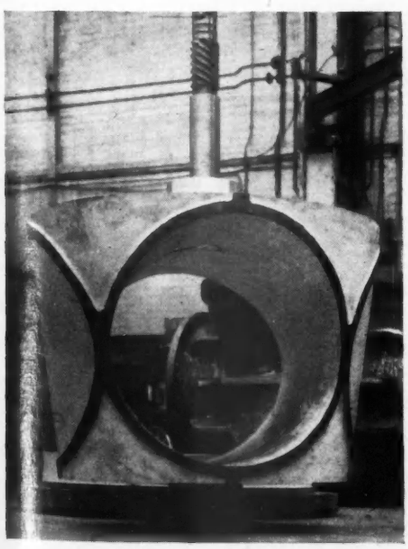

Fig 1 Threads on the plug shaft enable the plug to be lifted axially. Also shown here are the raised annular seating surfaces.

The body is fitted with a head cover, through which extends the plug shaft. The shaft links the plug with the operating mechanism, which is protected by a fabricated steel housing carrying the drive unit. Alignment of body, plug and operating mechanism is maintained by three bearings, which can be seen in Fig. 2. The arrangement of the bearings, low bearing pressures and the freedom of the valve seats during rotation of the plug combine to give rapid and easy operation of the valve against full unbalanced fluid pressure. No by-pass connection across the valve or other pressure-equalising device is required and control of the valve is therefore much simplified.

VALVE ACTION LIMITS WATER-HAMMER

In Fig. 3 are shown characteristic curves of several different valves with percentage valve-opening area plotted against percentage stroke of the operating mechanism. As is evident from the graph, the action of the Rotovalve, represented by the left-hand curve, is such that water-hammer is limited to a much lower value than that obtained with more conventional designs. When the valve is closing, 80 per cent. of the port area is cut off in 40 per cent. of the crosshead stroke; subsequently, although the crosshead continues to move at uniform speed, the rate of closure diminishes. This effect is an inherent feature of the valve and no external retarding devices are required to achieve it.

Rotovalves may be driven by hand, electric motor, or hydraulic or pneumatic servo-motor; the choice of power unit depends on the site and operating conditions. Fig. 4 shows the hydraulically-operated version. Irrespective of the drive unit adopted, the action of the valve mechanism, shown in Fig. 5, remains unaltered.

Fig. 2 is a section through a hand-operated model and indicates the manner in which the plug is lifted, rotated and reseated. A crosshead, which is linked with the handwheel through bevel gearing and a screw stem, is constrained to move in a straight line by two guide rods; connected to the crosshead by a lever and link is a lift nut, which engages with threads on the plug shaft. The plug shaft is rotated by a slotted lever in which rides a roller attached to the crosshead.

VALVE LIFTED, TURNED AND SEATED BY SINGLE MOTION OF CROSSHEAD

To open the valve, the operator turns the handwheel, thus raising the crosshead and rotating the lift nut; since the nut cannot move axially, the plug is displaced and consequently unseated. As the movement of the crosshead continues, the roller engages with the slotted lever, which, acting with the lift nut, rotates the plug shaft thereby opening the valve.

Towards the end of the crosshead stroke the

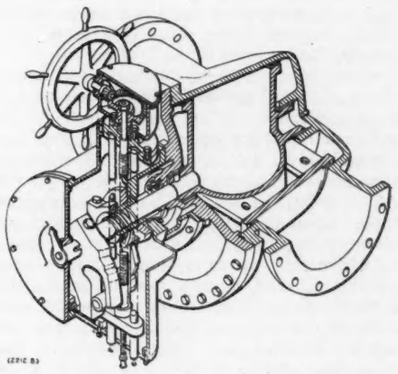

Fig. 2 In this sectional view is shown the mechanism which enables one man to operate the Rotovalve manually against full unbalanced fluid pressure.

connecting link to the lift-nut lever passes a dead-centre position and both the lever and the lift nut cease to move. Since, however, the rotating lever continues to turn, the lift-nut thread drives the plug shaft in an axial direction until the plug is reseated in the fully-open position. During the closing operation, the sequence of events is reversed.

In the electrically-driven version, the motor takes the place of the handwheel; in the servo-motor models the servo-mechanism is connected directly with the crosshead by a piston rod, which thus replaces the screw stem. In all versions of the valve, the unseating, rotation and reseating of the plug are achieved by a single straight-line motion of the crosshead.

UNOBSTRUCTED FLOW: VALVE AS VENTURIMETER

In addition to its normal isolating duties, the Rotovalve has a number of special applications and can, for example, be used as a venturimeter. Since the friction loss through a conventional valve is considerably greater than that through a Rotovalve of the same size, a smaller Rotovalve is normally employed and forms in effect the throat of a venturi section. In this way it provides a means of measuring and controlling the flow. The losses in a Rotovalve

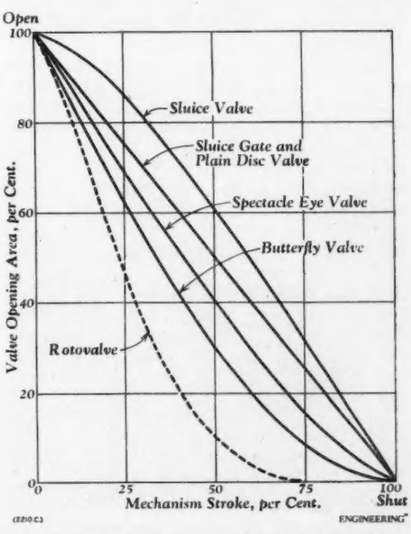

Fig. 3 Characteristic curves illustrating the manner in which surge and water-hammer effects are suppressed.

and a sluice valve are equal, the makers claim, if the diameter of the sluice valve is approximately 1·4 times that of the Rotovalve.

Other applications of these valves cover all forms of throttling commonly encountered and include pressure and velocity control. If the differential pressure across the valve does not exceed 60 lb. per square inch, downstream pressures can be maintained at low values not departing by more than 2 lb. per square inch from those required. Models with hydraulic or electric-motor drive can also serve as excess-velocity control points in order to isolate pipelines automatically when a break occurs and the hydraulically operated version can in addition combine the functions normally performed by separate isolating and non-return valves. The automatic non-return valve is governed to act in correct sequence with the operating characteristic of the pump it controls. The maintaining of surface levels in reservoirs is a further application of the Rotovalve.

HORIZONTAL OR VERTICAL PIPELINES

Rotovalves are suitable for use in pipelines, water-turbine penstocks, filter plants and sewage works. Very high velocities of flow can be employed and, since the valve seats are not in the path of the fluid, wear is negligible, even when raw water, sludge or sewage is passed. They can be installed in either horizontal or vertical pipelines and may be buried directly in the ground since, once filled with oil, they can be entirely sealed.

Because they permit uninterrupted flow, Rotovalves may be of the same diameter as and bolted directly to the pump-discharge and turbine-inlet branches. Intermediate taper pipe are thus unnecessary and more compact layout can be obtained. Slip-joints are likewise no required since the valves can be installed i such a way that the operating mechanism an the plug may readily be removed withou disturbing the pipeline connections.

The valve may be opened and closed quickl and easily by one man; this feature is of specia value in emergencies.

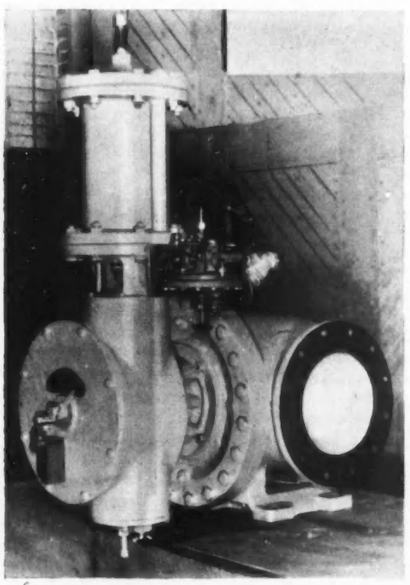

Fig. 4 The hydraulically-operated version shown here has such applications as the automatic isolation of pipelines on breakdown and reservoir-level control.

Fig. 5 Whether driven by electric, hydraulic or pneumatic motor or manually, the operating mechanism shown here remains the same.

THE WOODHEAD NEW TUNNEL

MAJOR RAILWAY TUNNEL DRIVEN THROUGH POOR ROCK

The Woodhead New Tunnel, a three-mile long main double-line railway tunnel through the Pennines on the Manchester to Sheffield line, and the first major railway tunnel to be completed in the twentieth century, was formally opened by the Minister of Transport, the Rt. Hon. Alan Lennox-Boyd, P.C., M.P., on Thursday, June 3. The construction of the tunnel with an overhead wiring system forms part of the electrification scheme of the Manchester-Sheffield-Wath lines on which we have already published two articles.* As was said by the Minister at the opening ceremony, the railways must continue to play the commanding role in the transport services of the country and the tunnel and new works associated with it would be of great importance in increasing the flow of heavy freight traffic, which is to be drawn by electric locomotives.

The problems met in the design and construction of the tunnel have been most fully described in the paper entitled "Woodhead New Tunnel: Construction of a Three-Mile Main Double-Line Railway Tunnel," by Mr. Peter Scott, M.I.C.E., and Mr. J. I. Campbell, M.I.C.E., presented before the Institution of Civil Engineers on March 16 last. Much of the material contained in the following article has been taken from that paper which is to be published in full, together with the discussion which followed its presentation, in Part I of the *Journal* of the Institution next September.

THE OLD TUNNELS

The New Tunnel has been built to replace twin single-line tunnels which were completed rather more than 100 years ago and which, though having given good service, have now deteriorated, principally in respect of the disappearance of the mortar in the joints of the stone lining. With traffic reaching more than 80 trains per day in each direction, maintenance work between traffic became at first difficult and then finally inadequate. In 1946, absolute possession of each tunnel alternately was given over a period of nine months so that repairs could be carried on continuously by both day and night shifts. At the end of the agreed period, however, it became apparent that the essential repair work could never be completed under circumstances allowing economic operating conditions and all the alternatives were considered. As a result, it was decided to construct the new double-line tunnel; the cross-section of the tunnel, circumscribing the Ministry of Transport's structure gauge was of sufficient size, without further enlargement, to contain the new arrangements for electrification of the railways using the 1,500-volt overhead system.

Authority for the work was obtained under the London and North Eastern Act of 1947 which, for the protection of certain bodies, included clauses giving rise to additional works and costs. In particular, it was required that any water arising from the new tunnel should be purified before being passed into the river Etherow, which flows close to the Woodhead end of the tunnel and feeds reservoirs belonging to the Manchester Corporation; this required the provision of a small water-treatment plant. The Act further stipulated the observation of the Town and Country Planning Act in respect of the siting and formation of the spoil tips.

The topography of this isolated area, in particular at the Woodhead end of the tunnel, is to be seen in the aerial view illustrated in Fig. 1.

LOCATION AND ALIGNMENT

The new tunnel has been driven parallel to the old tunnels and 100 ft. centre to centre from the nearer of the old tunnels, except for a short curve of 40 chains radius at the Woodhead end to allow a convenient connection to be made with the original track alignment. Though the old tunnels are straight, the traffic was so dense and the air so seldom free from smoke that it was impossible, for the purpose of survey, to obtain a through-sight from one end to the other. Consequently, the azimuth of the new tunnel could not be obtained from the old to an accuracy sufficient for the preliminary setting-out; for driving the tunnel and sinking the new shaft a full triangulation had to be carried out between two convenient tertiary ordnance survey stations.

The gradient of the existing tunnels throughout their length is a constant 1 in 203 rising from Woodhead to Dunford Bridge, but in the new tunnel the gradient rises at 1 in 129 from Woodhead for about two miles and then falls at 1 in 1,186 to the other portal. There is a parabolic vertical curve 800 ft. long at the summit. The reason for the alteration is that, by a modification to the signalling equipment, it could be possible to permit two trains to be on one line in the tunnel simultaneously.

Much information concerning the rock formations that were likely to be met were obtained from a detailed longitudinal section along the old tunnel and through five shafts, made by the resident engineer for the original work, Mr. W. A. Purdon, in 1845 and deposited in the Geological Museum, South Kensington. The condition of much of the rock through which the tunnel was driven, blocky sandstone or shale, is shown in Fig. 2.

THE CONTRACT DOCUMENT

Initially, the contract document was prepared in an orthodox form with 363 items and the usual rise and fall clauses to meet variations in the prices of labour and materials. Examination of the returned tenders showed, however, that owing to the known shortcomings of the rock

* "Electrification of the Manchester-Sheffield-Wath Railway," page 174 and page 321, vol. 173 (1952).

Fig. 1 Aerial view at the Woodhead end, showing the old and the new portals, with the tunnel-lining shutter assembled in front of the new portal, and the bridge across the river Etherow.

to be excavated and the consequent unpredictable risks, and the ruling uncertainties due to labour and materials, the contracting firms were covering themselves against possibly heavy risks by quoting high rates.

In these circumstances it was decided to re-invite tenders on the basis of a target sum represented by the total of the priced bill-of-quantities, and the payment of a fixed fee adjusted by bonus or limited penalty dependent on the actual cost and period of completion – specified as 42 months. Furthermore, it was arranged that the work should be financed through an imprest account in the name of the Railway Executive from which the contractor would be authorised by the engineers to draw cheques in his own name to recoup his actual outgoings. It was in this form that the contract was awarded to Balfour Beatty and Company, Limited, 66 Queen-street, London, E.C.4.

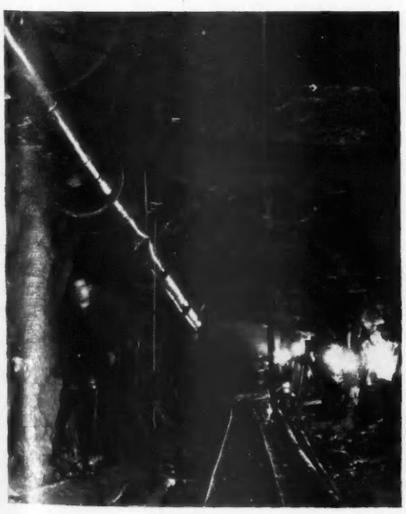

Fig 2 The broken nature of the rock strata through which the tunnel was driven is typified by this section of the pilot tunnel.

In their paper, Mr. Scott and Mr. Campbell express their opinion that, though the difficulties met during the course of the work were found to justify fully the departure from the orthodox type of contract, and a carefully-worded contract deed was drawn up in amplification of the contract documents, the system of contract adopted did not prove to be entirely satisfactory. For example, though it was the contractor who was responsible for the successful and economical completion of the work, the resident engineer had to give his approval for every purchase, methods of operation, salaries paid and bonuses offered. In all works, however, where there are unknown or unpredictable factors, no legal documents, however carefully phrased, can be devised to meet all the contingencies likely to arise and the satisfactory conclusion of the work is dependent on the mutual understanding between promoter, engineer and contractor.

PLANNING THE ENLARGEMENT

The contractor planned to drive a pilot tunnel, 12 ft. square, at mid-height of the finished tunnel, from each portal and from a central shaft and thereafter enlarge the tunnel by radial drilling working inwards from both portals. By this arrangement the drilling gangs would work continuously, using the shaft for supplies; the blasting gangs would follow after a suitable interval and blow a length of enlargement; and the mucking gangs would pull out through the enlarged tunnel to the portals. The most conservative forecasts of progress showed that the tunnel could easily be completed within the stipulated period with such an ideal programme of works.

Unfortunately, owing to the highly stratified nature of the rock, this plan proved to be unworkable. Holes drilled and charged radially blew a ragged and uncontrollable section, producing either an excessive overbreak or requiring excess trimming. The abandonment of radial drilling created a serious problem of re-organisation since, as that system utilised only one working shaft, only four faces were then available for the operation of face drilling. In contrast to radial enlargement it was possible, with face drilling, even in the shale, to blow a relatively well-shaped face and satisfactory profile by drilling a sufficient number of limiting holes around the periphery of the profile. As is noted later, however, the overbreak was even then far greater than anything that had ever been expected.

Nevertheless it was soon appreciated that the progress on four faces was not going to be sufficient to allow the completion of the contract within the stipulated period. Obviously, the opening up of enlargement faces at additional places was essential and plans were made to form and work from chambers broken out from the pilot tunnel at several points ahead of the main enlargement faces. Access to these additional chambers proved to be far from easy. Firstly, all traffic and services to them passed through the main face with consequent interruptions to the work there. Secondly, the greater part of the pilot tunnel had been driven centrally, that is to say, its invert was 6 ft. above the floor of the finished tunnel, and before traffic could pass the invert had to be lowered. When work at the inner faces became extremely difficult it became impossible to maintain a regular cycle of operations and, with the continuous threat of the inner gang being cut off by a heavy fall at the outer face, the impracticability of the arrangement soon became apparent.

BY-PASS TUNNELS DRIVEN

The programme of work again had to be changed due to a heavy fall of a 72-ft. length of the enlarged tunnel near to the Woodhead end. This fall clearly showed the need for immediate robust support for the 31-ft. roof-span when driving through shale, but the fall was such a size as to bring work at one face to a standstill for several months until the blockage could be cleared. Another fall is shown on page 22, where Fig. 4 shows the crippled roof supports. In order to gain access to the inner break-up behind the fallen rock it was decided to drive a haulage-way clear of the tunnel obstruction and so allow work to be resumed beyond the fall.

This was successfully done and the experience gained encouraged the idea that such haulage-ways, or by-pass tunnels, might be used wherever uninterrupted access was required to points in the pilot tunnel beyond the primary enlargement faces. Accordingly, a whole system of by-pass tunnels was driven and cross-connections made

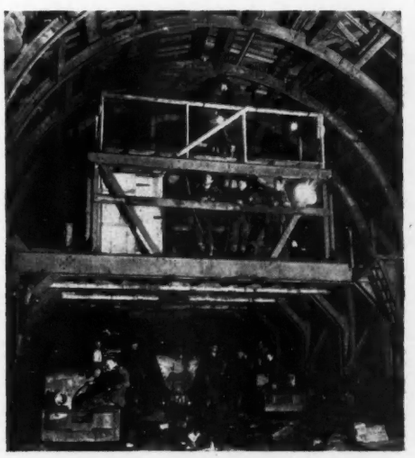

Fig. 3 Rear view of one of the drilling and ribbing carriages, shown in place behind an enlargement face in the shale.

Fig. 4 Roof fall, showing the crippled roof ribs (8-in. by 5-in. I-beams). Tips of shot holes can be seen in the wall rock, particularly the lower right wall.

Fig. 5 A 20-ft. length of the sidewall and arch shutter assembled before the Woodhead portal. The shutter folds about the crown pin and can also be lowered vertically.

to the pilot tunnel wherever necessary and, at one time, a maximum of nine enlargement faces were being worked, involving about 9,500 ft. of by-pass tunnel.

The greater part of the work of enlargement was done working full-face from a steel gantry such as that shown in Fig. 3, on page 21. The gantries were designed after it became apparent that the need for steel-ribbing supports would be the rule rather than the exception, and provision was made in the length of the carriage for the means to handle and erect the arch-ribs.

Overbreak throughout was extensive. The average overbreak, calculated from the concrete volumes put in, was 17½in. beyond the theoretical line round the outside of the walls and arch of the tunnel, representing 15 per cent. extra excavation. Although a more satisfactory profile was obtained than would have been the case had radial drilling been employed, overbreaks up to 6 ft. deep were common. Under these circumstances the amount of steel packing behind the steel ribs became prohibitive and this problem was overcome by placing primary concrete behind the ribs as packing.

CONCRETING THE TUNNEL

To concrete the side walls and arch, two large travelling steel shutters were built, one 100 ft. long operating from the east end and another 80 ft. long from the west end. The form of these shutters is shown in Fig. 5 which shows the boggie-mounted gantry carrying a steel skin which folded about a crown hinge and could be lowered bodily for striking and moving through the tunnel.

The materials were dry mixed outside the tunnel and transported in batch hoppers carried on bogie trains running along 2-ft. gauge track. The concrete was mixed, using water from the tunnel, in mixers located close behind the shutters and then pumped into place by sets of 4-in. pumps. The concrete was pumped, first through removable panels at the rear of the shutter, and then through successive valves in the crown, in order to fill the space between the shutter skin and the rock.

A "sloping flow" method of placing was effected thereby, in which concrete was built up as quickly as possible to crown level at the rear of the shutter against the shunt end of the last completed length; the pumps were then connected to the succeeding valves in the crown, allowing the concrete to be placed forward, so building up first the side-walls and then the top arch. To succeed in this the concrete used had a slump of between 1½ in. and 2 in. and "windows" were left in the shutter skin so that workmen with rakes and poker vibrators could more easily place and consolidate the concrete, and continuous inspection could be maintained.

To ensure full packing of the rock behind the ribbing and the lining, grout pipes leading to the worst or highest points were fixed to the back of the shutter and cast into the lining. Grouting was carried out using pans of 8-cub. yards capacity and at a maximum pressure of 50 lb. per square inch; the average cement acceptance over the length grouted was equivalent to a skin thickness of 4 in. over the top and shoulders of the arch.

The completed tunnel, with overhead wires carrying 1,500 volts D.C. for traction purposes and high-tension cables and telephone wire along the wall brackets, and with the track laid, is shown in Fig. 6.

Fig. 6 The completed tunnel, with overhead equipment, service cables and railway track in position.

LABOUR, PROGRESS AND COSTS

The dangerous nature of the work – six men did in fact lose their lives during the contract – the uncomfortable conditions underground and the limited social amenities which could be provided at the site, combined to make it difficult to obtain and retain suitable labour at the site. Although basic wages were supplemented by considerable guaranteed overtime and a production bonus, the annual labour turnover amounted to 400 per cent.; in part, the high earnings were a cause of the high turnover, for many men of the wrong type were attracted to the contract for short periods between other jobs of a more congenial nature.

The civil engineering contract was started in February, 1949, and completed in October, 1953, a period of 4½ years as compared with the target period of 3½ years. The total cost was about £4½ million, of which nearly £1 million was due to rises in costs of material and labour. The consulting engineers to the Railway Executive (Eastern Region) were Sir William Halcrow and Partners, who were responsible for the design and supervision of construction; the contractors were Balfour Beatty and Company, Limited. The whole of the work was carried out under the general direction of Mr. J. I. Campbell, M.I.C.E., Civil Engineer to the Eastern Region.

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ONE YEAR COURSE IN CONCRETE PRACTICE

The City and Guilds of London Institute have prepared a one year part-time course in Concrete Practice which is intended to lead to qualification for supervisors and potential supervisors engaged in concrete work.

The course is planned on a basis of 24 lectures, i.e., one 2-hour evening lecture per week, and the scheme will operate from the commencement of the session 1954/55. The first examination, which will consist of a written paper and an oral test, will be held in May, 1955, and certificates will be awarded to successful candidates.

Full particulars of the course can be obtained in pamphlet form (price 6*d.*) from the City and Guilds of London Institute, 31 Brechin-place, South Kensington, London, S.W.7.

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RESEARCH ASSISTANTSHIPS

Full-time research assistantships to the value of £350 a year are available at the Sir John Cass College, Jewry-street, Aldgate, London, E.C.3, in the departments of chemistry, mathematics, metallurgy, including geology, and physics. The purpose of the awards is to enable students who are suitably qualified to obtain training at the College in methods of research under supervision.

The assistantships are tenable, from September 1, for two years and may be extended for a third year. Research assistants are expected to hold the award for not less than one calendar year, continuation being subject to satisfactory progress. Holders of the awards will be required to undertake teaching duties for six hours weekly without further payment.

Application forms may be obtained from the Secretary of the College.

TRANSPORTING AND DELIVERING MATERIAL IN BULK

NEW WAGON REDUCES FLOUR-HANDLING COSTS

A new wagon, believed to be the first in Europe designed specifically for carrying and delivering flour in bulk, has been introduced recently by Henry Simon, Limited, Cheadle Heath, Stockport. The new vehicle, which was demonstrated before representatives of the flour milling, bakery and transport industries, is expected to make a major contribution towards keeping down the costs of flour distribution and to encourage the growing trend for bulk storage of flour in bakeries.

Whereas flour has been stored and transported in bulk in some countries overseas, especially in the United States, for some time, the unit of transport in Britain has continued to be the 140-lb. bag, although many millers have resorted to storing each 24 hours' production in bulk in an attempt to avoid the effects of rising labour costs and shortages, packing it for transport by high-speed machinery during the day shift.

In addition to high costs in labour, storing and handling flour in sacks has another drawback. The sacks are liable to insect infestation and are difficult to clean: they are a frequent source of infestation in the bakeries to which they are delivered. In order to reduce this danger, bakers have recently adopted systems of bulk storage, thus confining the use of sacks to the transport of the flour from the mill to the bakery. The time and labour involved in packing, loading, transporting, unloading and finally discharging a load of, say, 20 tons of flour is considerable (three hours is the average loading time) and it is here that the bulk wagon will fill an urgent need.

LIGHT-ALLOY BODY FOR HIGH PAYLOAD

The Simon bulk wagon, illustrated in Fig. 1, consists of an aluminium-alloy body, 24 ft. 6 in. long, 7 ft. 5 in. wide, and 11 ft. 9 in. high, mounted on a standard 22-ton chassis (the prototype vehicle has a Leyland Octopus chassis), and fitted with discharging apparatus developed by Henry Simon, Limited. The use of aluminium alloy has effected a substantial saving in weight over a similar body in steel, and has made possible the high payload of 12½ tons. The body is of patented construction in 14-s.w.g. high-tensile aluminium-alloy sheet, with vertical pillars of registered design.

In the body there are three longitudinal hopper bays sloping to the rear of the wagon, with a 9-in. wide Aeroflow discharger at the bottom of each. The steep sides of the bays direct the flour on to the dischargers during the unloading operations. Doors are fitted in the exterior panels to permit access to the working parts and to the control panel, etc. Inspection windows and a searchlight (all fitted with windscreen-type wipers to remove any flour adhering to the glass) enable the operator to check unloading at a glance.

The top of the body is fitted with three rectangular loading hatches (Fig. 2), each 5 ft. long by 2 ft. wide, and a walkway, which is reached by a ladder on the nearside front of the body. The loading hatches have rubber seals which serve the double purpose of preventing air loss and keeping the flour free from contamination; they are fitted with textile diaphragms which permit the controlled escape of the air displaced during loading.

The capacity of the bulk wagon is 850 cub. ft., giving a holding capacity of about 14 tons. The unladen weight on this particular chassis is 9 tons 11 cwt. 0 qr. 14 lb., thus giving a permitted payload of approximately 12½ tons. The wagon is loaded by gravity from bulk bins in the mill warehouse. This normally takes about 10 min.

FLOUR DISCHARGED BY "FLUIDISING"

At the bottom of each hopper bay is an Aeroflow discharger, consisting of a shallow trough closed at the top by a porous medium on which the flour rests. Compressed air is introduced into the trough from below and, blowing through into the flour mass above, aerates and "fluidises" the flour so that it will flow along a slope as flat as 6 deg.

A transverse collecting chute equipped with two short Aeroflow conveyors at the rear of the wagon receives the flour from the main dischargers and feeds it into two Simon blowing seals (Fig. 3) which meter it into the conveying air stream. The air supply for the Aeroflow dischargers is supplied by a positive-displacement blower mounted under the framing at the forward end of the body. Air for elevating the flour from the wagon to the bakery is supplied by a two-stage blower.

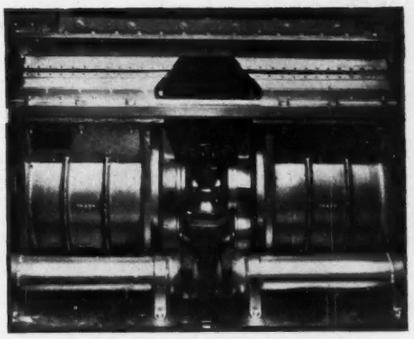

Fig. 3 Two Simon blowing seals meter the flour into the airstream and delivery pipe.

Both blowers are driven from a common shaft through V-belts, the drive to this shaft being taken from the power take-off on the gearbox of the vehicle. The common shaft also drives, through a transfer gearbox, the chain-driven blowing seals. The blowers have been specially selected and require no internal lubrication thereby eliminating the risk of oil contamination of the flour. The rate of discharge can be varied by adjusting a simple air valve.

Although the bulk wagon requires only one intake pipe, it may discharge to any one of a number of 3-in. pipes. Under normal conditions a full load can be discharged in about 45 min.

The operator can control the whole of the discharge process from a control panel fitted into the rear of the vehicle, without returning to the cab. The principal controls are a remote throttle control for the engine, operating handles for the cut-off slides which control the entry of flour to the blowing seals, selector-valve controls for the Aeroflow dischargers, and controls for the by-pass valves on both discharging and conveying lines. A gauge indicates the pressure in the conveying pipeline, and there is a revolution counter and a switch for the interior observation light. The throttle control incorporates a quick-release mechanism to shut off power immediately in the event of an emergency. Windows are built into the control panel,

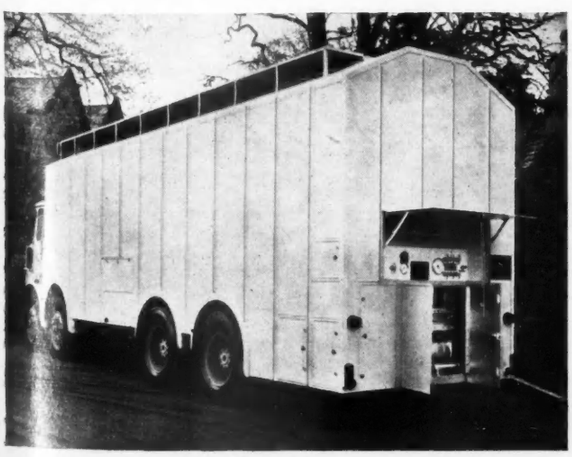

Fig. 1 The Simon bulk-flour delivery wagon, with an aluminium-alloy body mounted on a 22-ton chassis, can carry 12½ tons of flour. Three longitudinal hoppers direct the flour on to "fluidising" dischargers.

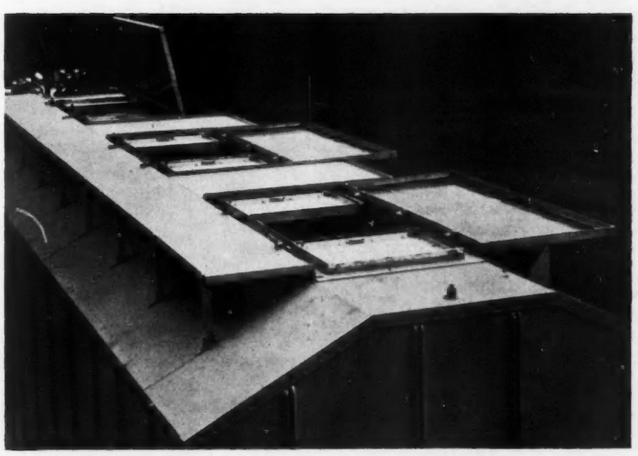

Fig. 2 The three rectangular loading hatches are fitted with rubber seals and textile diaphragms to control the escape of air displaced during loading, which is by gravity from bulk bins in the mill warehouse.

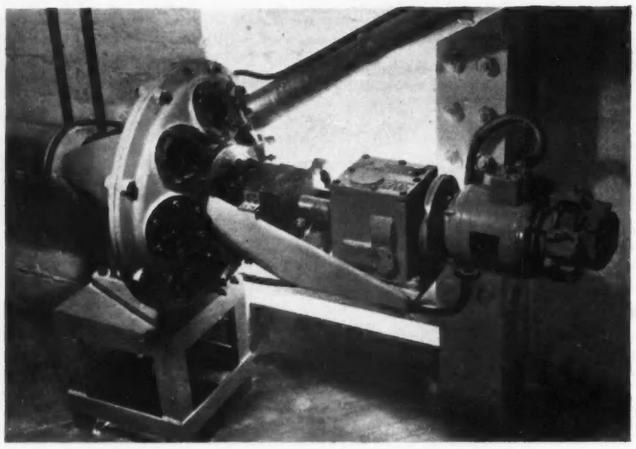

Fig. 4 Multiple-way electrically - actuated valve used to control the discharge of flour to any one of eight receiver bins.

permitting observation of the Aeroflow dischargers and of the interior of the body. Below the control panel are doors giving access to the discharge connections to the blowing seal.

For the purposes of the demonstration, the wagon was discharged into a bulk-flour intake plant in the Simon experimental mill. The plant is similar to those currently being installed in a number of bakeries and biscuit factories, and consists of a single intake pipe with a multi-way rotary valve, of the type shown in Fig. 4, herewith, to distribute the flour to any one of a number of bins. Above each bin is a flour collector which separates the flour from the conveying air and discharges it into the bin. In a typical bulk-handling plant at a large bakery, the flour would be extracted from the bins when required and conveyed pneumatically to the dough mixers. The entire process of flour milling and bread baking is thus made completely automatic from the arrival of the wheat at the mill to the loading of the baked loaves for delivery from the bakery; in addition, this important foodstuff is handled and transported hygienically.

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INSULATING FISHPLATES

Extreme Service Conditions Shown in Film

A film entitled " A Clear Road Ahead," presented by Permali Limited, Bristol-road, Gloucester, was shown on the occasion of the International Railway Congress. The film illustrated the manufacture and use of Permali insulating fishplates and made special reference to their contribution towards efficient signalling.

By linking consecutive lengths of track, the train wheels complete an electric circuit thus indicating in the appropriate signal boxes the train's position. Insulating fishplates permit this action, and the makers claim that there has never been a case of electrical failure with their plates.

Demonstrating the reliability of these fishplates under all conditions were film sequences showing them in service throughout the world. Extremes of heat and cold were represented by India and Canada, severe shearing, bending and shock by gradient operation with heavy ore trains in Norway and humidity by Great Britain.

Permali fishplates are made in various forms and can be adapted to connect lines of different section. To ensure that all necessary components are available when required, each pair of plates is fitted in advance with nuts, bolts and washer plates. Permali, which is a compressed wood laminate impregnated under vacuum with synthetic resin, has a tensile strength of 28,000 lb. per square inch and an impact strength of 5·5 ft. lb. It breaks down electrically along the laminae at 45 volts per mil.

DRY-TYPE AIR-COOLED TRANSFORMERS

Silicone-Impregnated Insulation Improves Operation

Transformers (Watford), Limited, Sandown-road, Watford, Hertfordshire, are now manufacturing dry-type air-cooled transformers, a special feature of which is the use of silicone-impregnated " Class H " insulation. These transformers, which have an output of 500 kVA and a ratio of transformation of 11,000/433 volts, are intended for employment on distribution networks and have been designed for continuous operation at a temperature of 180 deg. C. Under overload conditions or high ambient temperatures, operation at considerably higher temperatures is, however, possible without risk of explosion or fire. This result has been achieved without any increase in overall dimensions compared with a conventional oil-immersed naturally cooled transformer of the same output; and there is also a saving in weight. Generally speaking, construction follows normal practice and is in accordance with the appropriate British Standard specification, as will be seen from Fig. 1, which shows a core and windings undergoing a water test at 11 kV. Fig. 2 is an illustration of the transformer in its casing.

It may be recalled that Class H insulation consists of mica, asbestos, fibre grass and similar inorganic materials in built-up form with binding substances composed of silicone compounds or materials with similar properties. The chief characteristics of these materials which are important in transformer manufacture, are their water-repelling properties, long life at high temperatures and freedom from risks of fire.

To use these materials satisfactorily new winding and assembly techniques have had to be developed. It has also been necessary to instal automatically controlled high-temperature ovens to carry out the long curing which is necessary when Silicone-impregnated windings or insulation is used. To determine the temperatures and gradients under full load conditions, thermocouples were incorporated in the cores, windings and ducts of a prototype.

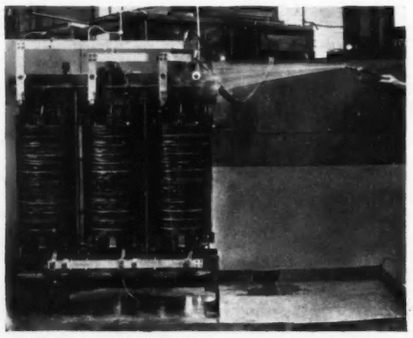

Fig. 1 Core of 500-kVA transformer with Silicone-impregnated insulation undergoing a water test.

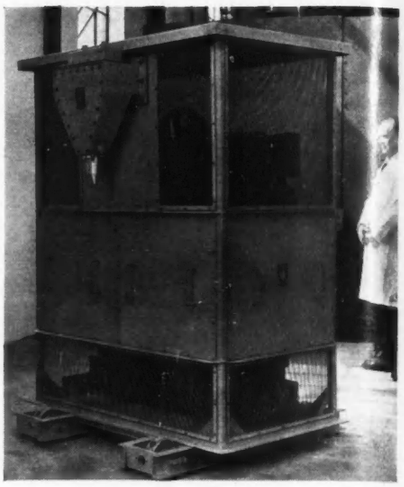

Fig. 2 Housing of 500-kVA Silicone-impregnated transformer.

Although the cost of Class H insulation is at present high, it is hoped that it will be reduced as more experience is gained. Justification of the many advantages claimed for its use in dry-type transformers should also lower costs.

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MODEL FORM OF CONTRACT

Electrical and Mechanical Plant

A new model form of general conditions for incorporating in contacts, known as " B3," has been prepared by the joint committee on model forms of general conditions of contract of the Institution of Mechanical Engineers and the Institution of Electrical Engineers, and published under the authority of their Councils. Copies are available, price 5*s*., from the Institutions.

The new form, the full title of which is " Export Contracts (Including Delivery to and Erection on Site of Electrical and Mechanical Plant)," supersedes the provisions of the existing form, " B2," which dealt with this type of contract for electrical work. Form " B2," however, is still available for electrical export contracts involving the supervision of erection only.

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SAW SET FOR CIRCULAR SAWS

A new adjustable tool, known as the Eclipse No. 79 saw set, for setting the teeth of large circular saws up to 10 s.w.g. thick has been developed by James Neill and Company (Sheffield), Limited, Napier-street, Sheffield, 11.

The depth of set can be controlled by adjusting the sliding tooth stop by means of a small knurled nut on the head. The depth of set is indicated on an anvil scale marker in sixteenths of an inch. The amount of set can be controlled by a large graduated thimble. As the amount of set required depends upon the size and type of saw, the timber to be cut, etc., the exact adjustment necessary has to be determined by trial. When the tool has been adjusted to the required depth and amount of set, the saw can be set. The tool is inclined to the same angle as the saw tooth and the setting plunger is operated by squeezing the handles.

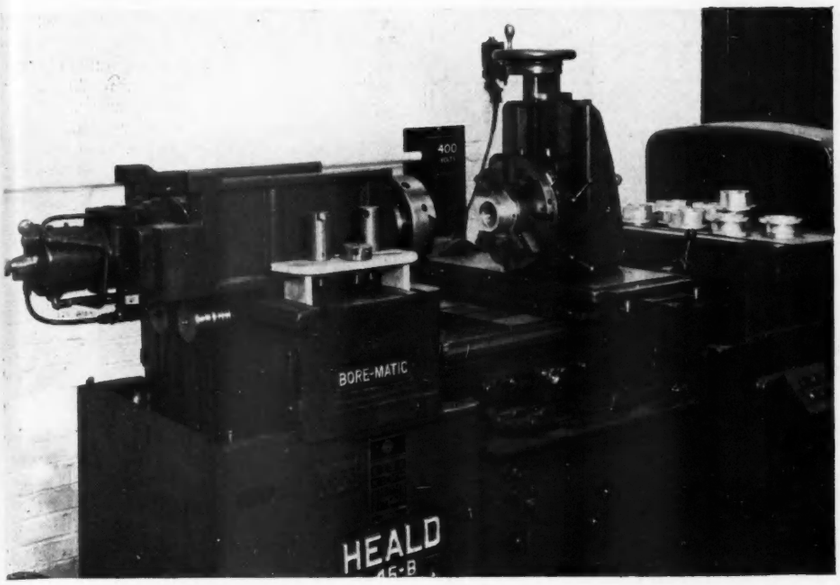


Fig. 1 The Heald "Bore-matic" machine to which the tape control system was applied. All limit switches and relays were dispensed with, and any machining operation could be performed.

AUTOMATIC CONTROL FOR MACHINE TOOLS

GOVERNING BY MAGNETIC TAPE RECORDINGS

Among the many schemes being worked out for the automatic control of machine tools, Alfred Herbert, Limited, Coventry, have developed a system using magnetic-tape recordings. This has been successfully applied to a Heald "Bore-matic" precision boring machine of the type shown in Fig. 1. These machines are normally hydraulically actuated and can be set up to perform a limited series of operations by a system of limit switches and relays. When a different operation is required, all the limit switches have to be reset, a process which becomes very lengthy when a complicated cycle of operations is involved.

With magnetic-tape control, however, all the limit switches and relays are dispensed with, and the control is applied directly to the solenoid-operated valves of the hydraulic system. The complete control equipment for the prototype trials is shown in Fig. 2. Each of the hydraulic valves controlling the movements of the machine-tool is operated by a slave relay. These slave relays are each actuated from a tuned circuit which is responsive to one frequency only. For the initial recording a frequency generator is required to supply the signals for circuits, a standard commercial recorder being used.

To make the instruction record, the machine controls are operated by push buttons which, at the same time, control the frequency produced by the oscillator. These frequencies are recorded on the tape as they are produced, the record of each one lasting as long as the operation on the machine. In this way a time/frequency record is made corresponding to the movements of the slides. Consequently, when the record is played back, the tuned circuits will respond to the various frequencies, and the machine will repeat every one of the original movements. It is quite possible for two or more movements to take place simultaneously, for the operations that can be carried out are only limited by the capabilities of the machine. Should a mistake be made during the recording, either the whole or just that section can be magnetically erased and re-recorded. In addition, the tape can be mechanically cut and spliced if it is desired to eliminate some motion, or to introduce a new one. The number of complete cycles which can be set up is limited by the length of tape used – with the commercial recorder of the trial tests, the tape was long enough for an hour's operation.

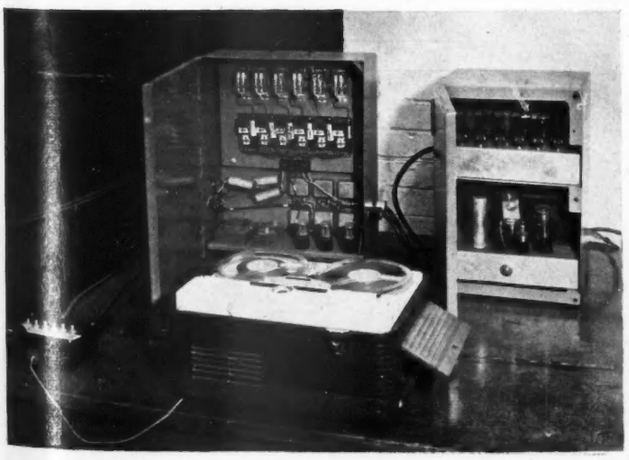


Fig. 2 The equipment required to make and use the magnetic tape control record. At the extreme left, the push-button panel for making the recording; behind, the panel of tuned circuits and the oscillator for generating the frequencies used; in front, a commercial tape recorder which will run for an hour.

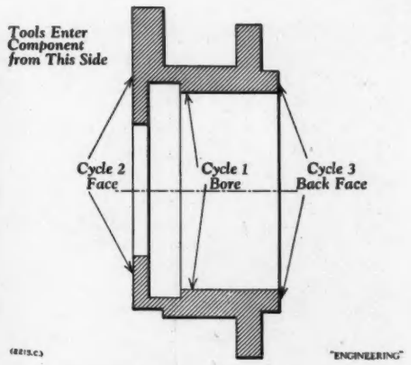


Fig. 3 A component made with a tape recording. Three separate cycles are involved.

MULTI-CYCLE OPERATIONS

A component successfully machined by this method is shown in Fig. 3. Three separate operations are involved in machining the two faces and the bore. Setting up for these by using limit switches and relays would be an almost impossible task, but with the tape control it becomes completely straightforward. When used with the Bore-matic machine, the accuracy of finish is not dependent on the recording, but on the dead-stops of the machine. Before recording, the hydraulic circuit is preset to give certain rates of feed and the recorded signal ensures that the slide squeezes against the dead-stop with the hydraulic oil viscosity at its lowest. The tape control, therefore, is used for patterns of behaviour rather than for exact measurement. It is not economical to make the tape recording an absolute reference when the accuracy can be defined by dead-stops.

The tape control system can be applied to any machine actuated by electro-responsive devices, enabling new work to be accommodated without revision of shop planning. Thus different parts could be made on the same machine simply by using a different record. Profiling and three-dimensional contouring could be carried out and repeated as required without the necessity of storing large patterns or models.

It does not yet seem to be an economic proposition to make the recording direct from drawings and then use it on the machine; there are many difficulties and the extra equipment would be costly and complex. Also, a skilled operator can take advantages of the characteristics of his machine to produce work of a high quality; this would be imparted to some extent to a recording made by an operator, but would be entirely lacking with mechanical recording. If the manual operations are too involved to be carried out under normal working conditions, they can be separately recorded at slow speed, or the tape can be stopped while the next sequence is planned or the tools finally set up. Then when the whole has been completed, the recording can be played back at normal speed. Although this method of control has been evolved specifically for machine tools, it can obviously be used for many other purposes.

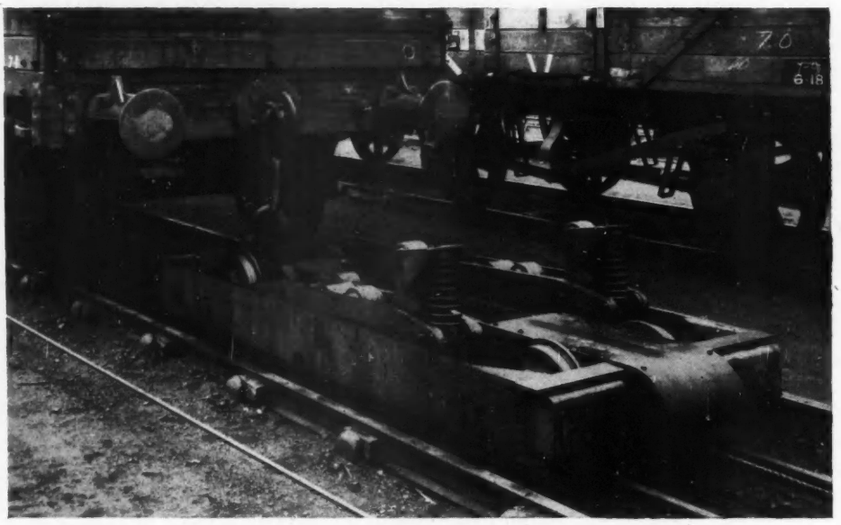


Fig. 1 The " Wagontroler," haulage bogie is remotely controlled and can be engaged, disengaged, and used to move wagons in either direction without being in view of the operator.

REMOTE-CONTROLLED MARSHALLING GEAR FOR RAILWAY WAGONS

AUTOMATIC OR MANUAL OPERATION

Movement of railway wagons through loading or discharging stations at collieries, power stations, gasworks and factories is a matter which has engaged the attention of railway engineers and others for a considerable period. There have been many attempts to reduce or even to eliminate the use of shunting locomotives and the personnel required for their operation. The alternatives usually adopted include mechanically-operated marshalling equipment, capstans, and, where conditions permit, the installation of tracks on inclines, with track brakes, or with simple manual control of the wagon brakes. Inclined tracks suffer from the disadvantages of erratic operation under various climatic conditions, and danger to shunters and brakemen at night and at other times of bad visibility. Mechanical wagon marshalling equipment hitherto evolved has been limited in operation to simple mechanical haulage or propulsion of wagons, without provision for complete control under various track conditions. Ever-increasing rates of loading and discharging encountered under modern conditions have rendered the problem of wagon handling all the more acute.

The " Wagontroler," developed and patented by Nortons-Tividale, Limited, Hecla Works, Tipton, Staffordshire, places the complete control of the wagons on one or more tracks in the hands of a single operator at a remote-control point. The operator can haul, " spot " and brake wagons by remote control on an upgrade, a downgrade, or on the level, under all conditions, and, if necessary, without having the wagons in view. The movement and control of the wagons is effected by a haulage bogie running on narrow-gauge rails fixed to the sleepers of the standard-gauge track. The bogie is operated by an endless-rope haulage system, and is so equipped that wagons can be engaged and disengaged either automatically by mechanism on the haulage winch, under sequence control, or at the operator's will, as desired. The bogie is shown in Fig. 1 approaching a wagon to engage it.

Trains of ten 10-ton wagons, or their equivalent, amounting to a gross train load of 170 tons, can be handled on gradients of up to 1 in 70, and this figure can be exceeded on level tracks. Standard designs provide for operation over distances of up to 600 ft., at a haulage speed of up to 75 ft. per minute, enabling rates of loading up to 100 tons per hour per track from booms, or 400 tons per hour per track from hoppers to be achieved. Similar rates of discharge are possible. The positive control of the haulage bogie over a wagon or train of wagons makes it possible for them to be positioned accurately, without viewing, to within 6 in. at any point on the track between the end terminals, by the setting of limit switches, or by manual control with a position indicator. The equipment can operate on straight or curved tracks, and is accepted by British Railways as satisfactory for hauling all types of wagon.

A typical installation for a coal-preparation plant allows for a length of track of 600 ft., 200 ft. being allocated for standing empty wagons, which are allowed to gravitate into position or left by a locomotive, 200 ft. for movement of wagons while loading, and a further 200 ft. standing room for loaded trains awaiting collection by locomotive. In operation the bogie is hauled out to a train of waiting empty wagons, stopped automatically, the wagon-engaging gear is raised, and the bogie is then advanced at a reduced speed to engage the axle of the leading wagon. Contact with the wagon axle causes two pairs of gripping rollers to be tilted to embrace the axle. Catches lock the rollers in position automatically, and the movement of the bogie is stopped by a cut-out mechanism on the haulage winch. The train is then hauled to the loading point, at which, by " spotting," " inching " and, if necessary, reversing the bogie, all under remote control, each wagon is brought in turn under the loading boom. Layer loading can be carried out if required by hauling the wagons backwards and forwards under the boom. Fig. 2 shows the bogie with the rollers engaging the wagon axle.

After loading, the train is hauled to the lower terminal point on the track, the bogie is stopped automatically, and the axle-engaging gear is retracted, leaving the train free and ready for collection by a locomotive. The bogie is then hauled back below the loaded train, at a speed of up to 150 ft. per minute, towards the upper end of the track, to engage a fresh train of empty wagons, and repeat the cycle. Discharge of wagons by a rotary- or side-tippler would involve a slightly different arrangement of the equipment, as would passing the wagons over a weighbridge, but the basic principle remains the same in all the applications.

THREE MAIN UNITS

The equipment consists of a haulage bogie with remote-controlled wagon-axle engaging gear, a winch unit, and a control station; the two latter can be sited in different positions as convenient for constructional or operational purposes. The haulage bogie travels on a narrow-gauge track consisting of 25/30 lb. per yard flat-bottomed rails, fixed to sole-plates on the sleepers of the main wagon track. The bogie is moved by a wire rope, which passes over return sheaves at each end of the bogie track, and returns on the outside of the main wagon track. Guide rollers are provided for the return rope in the normal way. At some

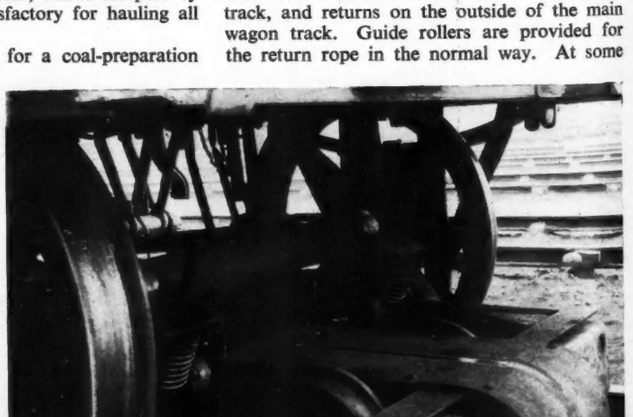


Fig. 2 The bogie having engaged with the wagon, the axle is gripped between the rollers. The springs reduce the shocks both to the wagon and the haulage gear. Trains up to 170 tons in weight can be moved on gradients of 1 in 70.

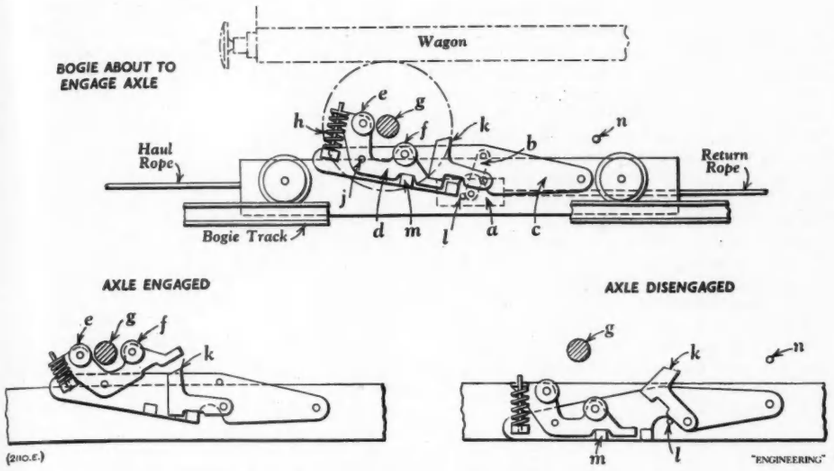


Fig. 3 The three conditions of the engaging mechanism of the bogie. Operation is effected by varying the tension in the haulage rope.

point in the return rope the winch unit is sited, the exact position being determined by conditions at the particular plant. The winch can, for example, be fixed above ground in a coal-preparation plant structure, or in any other convenient building. Alternatively, it can be installed in a pit in the ground. Both these arrangements are shown in Fig. 4 below. If the latter method of fixing is adopted, the haulage winch pit is the largest excavation needed for the complete equipment. The other excavations required are two small pits for the rope return sheaves, one at each end of the bogie track. Another small pit may be necessary to accommodate the drop-weight tension gear, to which reference is made later. This item can, however, be fixed above ground, if there is a position available.

REMOTE-CONTROLLED BOGIE

The sequence of operations in engaging, traversing, and releasing a wagon can be followed from the diagram above, Fig. 3. Control of the wagon-axle engaging gear is effected by varying the degree of tension in the haulage rope, which is under the control of the operator at the remote-control point. When the tension in the rope is just sufficient to traverse the bogie, the axle-engaging gear is retracted, being weighted to fall to this position. This is the " axle disengaged " position in Fig. 3. When the rope tension is increased, it causes a cross-head (*a*), mounted in the bogie frame, to slide, and this, by means of two toggles (*b*), raises a pair of long levers (*c*). These carry, near their extremities, forked levers (*d*), on each fork of which is a roller (*e* and *f*). The rollers are arranged to make contact with the wagon axle as near as possible to the insides of the wheels, so that the bending moment on the axle is kept as low as possible. When the levers (*c*) rise, the forked levers (*d*) are held by springs (*h*) so that rollers (*f*) will pass under the axle (*g*) (the " about to engage " condition in Fig. 3). Continued movement of the bogie brings the rollers (*e*) into contact with the wagon axle, and causes the forked levers (*d*) to swing on their pivots (*j*), until the follers (*f*) are raised into position behind the axle. In rising, the forked levers (*d*) displace catches (*k*), which then fall under the ends of the forked levers, and so lock them into position, giving the " axle engaged " position of Fig. 3. The springs (*h*) are still only partly compressed, and this provides for shock absorption if the moving wagon makes contact with a stationary one. Similarly, in their extended position the springs act as shock absorbers when the bogie is engaging a wagon.

With the rollers in their highest position the wagon, and those coupled to it, can be propelled in either direction by moving the bogie, and the whole train is thus under the complete control of the operator. When the train reaches the end of the bogie track, and the operator wishes to disengage the wagon axle, it is only necessary to reduce the tension in the rope. This allows the forked levers (*d*) and the long levers (*c*) to fall, and, by means of the toggles (*b*) to push the cross-head (*a*) back to its starting point. In falling, the long levers (*c*) cause the catches (*k*) to come into contact with fixed stops (*l*) which lift them and allow the forked levers (*d*) to swing under pressure from the springs (*h*) and rest on stops (*m*). The bogie is now able to clear both the axle and the brake-rod (*n*) which is the lowest transverse component of the wagon, and it can be traversed under the wagon back to the starting point, ready to repeat the cycle.

SELF-CONTAINED HAULAGE WINCH

The winch is a self-contained unit, designed for installation in a shallow pit between the main tracks at minimum recognised centres, or for location within a building structure, whichever is convenient. The haulage rope is led in at one end of the winch unit, makes several turns round a traction sheave and an idle sheave, and finally, before leaving the opposite end of the winch unit, passes round a tensioning pulley, which is slide-mounted. The rope is looped round this pulley, the length of the loop being variable according to the position of the slide carrying the pulley. A reversible electric motor, driving through a fluid coupling, bevel gears and a nut and screw, enables the operator to lengthen or shorten the rope loop at will. Lengthening the loop has the obvious effect of shortening the amount of rope in service outside the winch unit, and this causes a drop-weight, which provides normal bogie-traction tension, to rise. In doing so, it makes contact with a larger tension weight resting on fixed stops above it, and lifts this weight, so increasing the tension in the rope, and operating the wagon-axle engaging gear on the bogie. The drop-weight tension gear, as mentioned earlier, can be fixed in any convenient position in the layout.

Two types of winch unit are available, one with three motors for major duty and maximum haulage and bogie return speeds, and one with two motors for lower speeds. In the larger winch unit, the main haulage motor, which propels the bogie when it is engaged with a wagon axle, is a 25 brake-horse-power totally-enclosed slip-ring type running at 725 r.p.m., and designed for heavy " inching " duty. It is reversible, and can be used to move wagon trains in either direction. The drive from the motor to the main traction sheave is positive, through epicyclic gear, bevel gears and a spur and pinion, so that regenerative braking can be employed on downgrades, where the tendency is for the train to overhaul the winch. An electro-magnetic brake is also fitted in the drive from this motor to the rope sheave, and a fully-loaded train can be stopped and held by this brake on a downgrade of up to 1 in 70. The brake operates immediately the current supply is interrupted, either by the operator or by accidental failure. For hauling the bogie with the axle-engaging gear retracted, a 5-brake-horse-power 920-r.p.m. totally-enclosed reversing motor is provided. It is coupled to the epicyclic gear by a traction-type fluid coupling, which permits some slip when the haulage bogie engages a wagon axle; at this point the motor is cut out, and stops automatically. The third motor in the winch unit is a 4-brake-horse-power totally-enclosed reversing type, running at 680 r.p.m., and driving, through a fluid coupling, the screw gear which controls the rope tension.

The alternative design of winch unit incorporates a reversible haulage motor of 20-brake-horse-power, driving the rope sheave through reduction gearing to give a haulage and bogie return speed of up to 40 ft. per minute; there is no separate bogie-return motor. The rope-tension motor is the same as in the larger winch unit. Limit switches are provided in both types of winch unit to prevent over-running of the haulage bogie at each end of the track. These are operated by a screw and nut, mounted on the end of the winch frame, and driven by a chain from the idle rope sheave. The travel of the bogie is thus limited according to the actual amount of rope which has been paid out and there is no possibility of inaccuracy due to slip which may occur in the drive.

CONTROL GEAR

The electric control gear is installed at a point where the operator can see the wagons being loaded or discharged. There is no necessity for the operator to be able to see either the pick-up point where the trains are engaged or the point where they are left for locomotive collection; indeed, it is often impossible to arrange for such conditions. In a coal-preparation plant, for example, the operator's view of part of the sidings will be obscured by buildings. Similarly, since it is quite feasible to operate the equipment

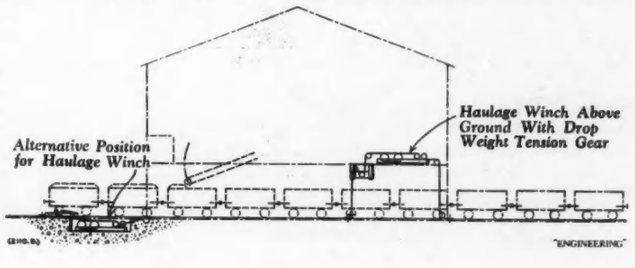


Fig. 4 The haulage winch can be placed at any convenient point in the return rope. This diagram shows alternative positions. It also shows the drop-weight tension gear used in the control of the engaging mechanism.

on a curved track by providing suitable guide rollers for the rope, wagons on an adjacent track may obscure the view. Provided that the wagons are brought to any point within the limits of bogie travel, the bogie will engage them automatically, whether the operator can see them or not, and will release them as required. The positive control of the bogie over the wagons enables positioning to be carried out automatically to within about 6 in. at any point of the track if required, by setting the limit switches accordingly, provided that the speed is reduced by the operator as the point is approached to allow for braking. To enable this to be done when the point in question is invisible to the operator, position indicators can be fitted. These indicators are operated in the same way as the limit switch gear.

Siting of the control gear has always to be determined by conditions at the particular installation, and by consideration of what other equipment the operator has to control. In some cases, for example, it may be possible for the operator to deal with up to four tracks, in which case the control gear for the four haulages can be grouped, together with the controls for other equipment such as loading booms, in a single cabinet. Because of the varying conditions from site to site, there is no standard form of control gear. It may consist of direct-on-line contactor starters, of the totally-enclosed ironclad pattern, with "inching" control operating in both directions, the apparatus being designed for 100 stops and starts per hour. Alternatively, a drum-type reversing controller may be fitted, if desired, to control the main haulage motor. The whole of the electrical and mechanical apparatus is designed in full compliance with the requirements of the Factories and Workshops and Mines and Quarries Acts.

TANKER HEATING COILS OF ALUMINIUM ALLOY

LIGHTWEIGHT CORROSION-FREE INSTALLATION

Shown in the illustration above is a lightweight corrosion-free oil-storage tan-heating coil installed in a tanker. The aluminium alloy coil has been developed by Steels Engineering Installations, Limited, Crown Works, Sunderland, and, it is claimed, results in a weight only 25 per cent. of that of an equivalent cast-iron installation and 35 per cent. of that of an equivalent mild-steel installation.

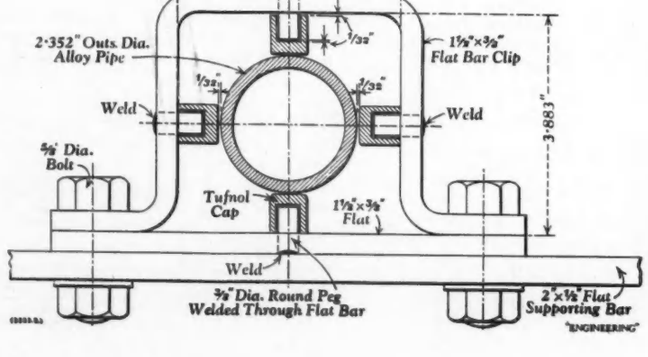
Crude oil, bunker and fuel oil, and the heavier hydrocarbon fluids generally, require to be heated before they can be conveniently pumped from the storage tanks of the tanker vessel. The traditional method for heating the oil is by a system of 2-in. nominal-bore mild-steel steam-pipe coils evenly spaced throughout the tank at a low level. This gives a convenient form of heat distribution and a system in which the heat emission of the available surface is correctly related to the steam-carrying size of the pipebore.

Owing to the varying types of oils encountered, however, and the alternating use of sea-water ballast in tankers, the mild-steel coils tend to corrode rapidly and to require relatively frequent replacement. Systems of cast-iron coils have been successfully employed using pipes of varying bores and wall thickness, both plain and finned. One such system was described in ENGINEERING, vol. 175, page 601 (1953). The cast-iron piping has a much greater resistance to corrosion, but is heavier and more susceptible to fracture.

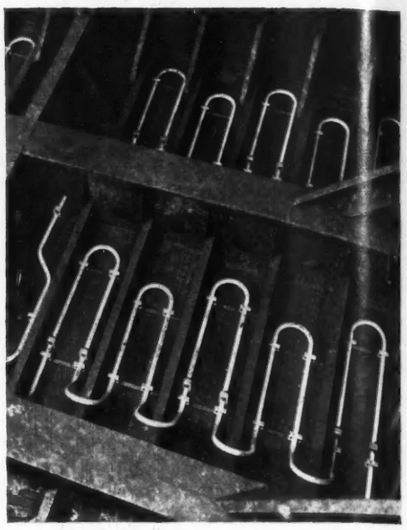
The use of non-ferrous pipes, lighter and more resilient than cast iron, is attractive if the installation can be made free from chemical and electrolytic corrosion. In the Steels' Engineering system, this has been achieved by employing a highly corrosive-resistant aluminium alloy, with the following mechanical properties: ultimate tensile strength, approximately 12 tons per sq. in.; 0·1 per cent. proof stress, approximately 7 tons per square inch. The alloy is reasonably hard and the pipes are not therefore liable to accidental damage.

The heating tubes manufactured from this alloy are solid-drawn seamless pipes with an internal diameter of 2 in. and an external diameter of 2·352 in., giving a wall thickness of 0·176 in. The pipes are prefabricated by means of specially designed equipment and are joined by flanges of a die-cast aluminium alloy, having a spigot and faucet joint and a four-bolt fixing. The method of fixing the flanges to the pipes provides a joint of great strength capable of withstanding high stresses, particularly those along the axis of the pipe which are liable to be set up by expansion and contraction; it remains steam-tight under all conditions encountered in port and at sea.

To avoid electrolytic corrosion, it is essential to insulate the pipe coils from the steel structure of the ship and for this purpose the system incorporates a patented pipe support, shown in the illustration below, providing accurate location of the pipe, ease of fitting, freedom of movement for expansion and contraction, and complete electrical insulation. An essential part of the system is the combined steam strainer and conditioner in which any condensate in the incoming steam mains is trapped.



Arrangement of the pipe support which ensures freedom from aluminium-to-steel contact.



Aluminium-alloy pipe coils for steam-heating the oil storage in tankers.

Although, because of the slow convection properties of the heavier oils, the heat cannot be taken away from the pipe sufficiently quickly to take full advantage of the greater thermal conductivity of the aluminium alloy, the heat transference from steam to oil is greater per square foot of heated surface than can be obtained with either the mild-steel pipe or the cast-iron pipe, whether plain or finned. Some economy in heating surface is thereby achieved.

Little or no advantage is obtained by increasing the heating surface per lineal foot by the addition of fins, as the benefit of this could only be felt by arranging the coils at wider spacing in the tank, thereby providing uneven heating of the cargo. The alternative, of using a smaller-bore pipe with a greater heating surface provided by fins, is unsatisfactory, because the steam-carrying capacity of the small-bore pipe throughout the length of the coil is disproportionately low in relation to the total heating surface. The system as installed takes full advantage of the better thermal conductivity of the special alloy, and at the same time retains the benefits of even distribution of heating surface.

In a typical tanker of, say, 16,000 tons deadweight, the manufacturers claim that this system represents a saving of approximately 55 tons over the weight of a cast-iron installation, and 32 tons over that of a mild-steel installation.

Being readily fabricated, the alloy lends itself to the type of installation in which, as also in the case of mild-steel coils, it is unnecessary to enlarge existing holes or make new holes in the frames of the ship's structure. Arrangements for making and fitting the new system in Scotland have been made with Archibald Low and Sons, Markland-street, Glasgow.

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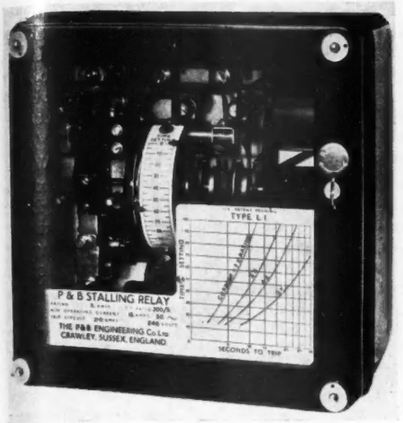
AIR-CONDITIONING CABINET

A small air-conditioning cabinet has been developed by the Thermo Control Installations Company, Limited, 2-10 Valentine-place, Blackfriars-road, London, S.E.1, for the accurate control of air temperature and humidity. It is suitable for use in standards rooms, laboratories, and offices. The standard size of cabinet is suitable for a room of approximately 3,000 cub. ft. For larger rooms where duct distribution is required other sizes are made. Automatic controls are fitted to the cabinet. These, the makers state, maintain an accuracy of ± 0·5 deg. F. and control the humidity to ± 1 per cent.



This relay has been designed to trip out an electric motor when it has stalled. In one version, only one attempt to restart can be made before the relay has to be reset.

PROTECTION AGAINST STALLING

Relay to Prevent Electric Motors Burning Out

A relay has been developed by the P. & B. Engineering Company, Limited, Crompton-way, Crawley, Sussex, to protect electric motors against stalling. Basically, the relay consists of a contactor and a thermal overload unit. The former is normally open, only closing during starting or when the motor stalls; in the open position, it short circuits the thermal element. The trip mechanism is operated by the thermal unit after a pre-set time interval; there is a long resetting time to allow the motor to cool somewhat before it can be restarted. One version of the relay is shown in the illustration.

The short-circuiting contactor closes at three times the normal current in standard models, but it can be set for any value between $2\frac{1}{2}$ and seven times the rating. It drops out at twice the normal current. This means that during normal starting the thermal unit is only fed for a portion of the time and so does not have time, in conjunction with the delay setting, to operate the trip mechanism. This is aided by the inverse time/current characteristics of thermal relays. The bi-metal strips are directly heated from a secondary winding on the contactor coil (which thus acts as a transformer) and their movement is therefore "dead-beat." The three coils which, yoked together, make up the thermal unit, can be seen to the right of the time-setting indicator. Two of these are the operating coils while the third gives an automatic correction for ambient temperature between − 10 deg. C. and + 60 deg. C.

ONLY ONE RESTART

The flag indicator, showing the condition of the relay, can be seen on the right with the reset knob beside it. One model of the relay has a "twice in" mechanism which only permits one attempt to restart after a stall. A shunt-connected auxiliary relay operates in connection with a mechanical "gate" in the flag indicator, so that, after a second stall, the contactor is locked closed, and the relay must be reset by hand before any more starts can be made. Provision is made for locking the reset knob so that it can only be used by authorised persons. In this model, the flag indicator shows either "normal," "once stalled" or "locked out." Contacts can be fitted for warning lights in addition to the flag indicator. Resetting after one stall can be carried out with the motor running.

Models are available for any current rating up to 60 amperes, either for direct connection or through a transformer. There are different types for those motors whose normal starting time is less than 40 seconds and those which take longer than this; tripping times on the latter may be as long as 180 seconds at three times full load. The relay resets to 80 per cent. of its time setting in 5 minutes and to 99 per cent. in 20 minutes. Several different arrangements of the contacts and relays can be supplied. The relays will not give protection on faults other than stalling.

* * *

DIESEL ENGINE POWER PACK

Developing 44 Brake Horse-Power at 1,700 r.p.m.

A simple power pack consisting of a standard Fordson-Major Diesel engine and radiator shield mounted on a chassis pressed from $\frac{1}{4}$-in. sheet steel has been introduced by the Chaseside Engineering Company, Limited, Station Works, Hertford. It is shown in the illustration below. The engine used was originally developed for use in an agricultural tractor but has since been adopted by many companies for driving a wide variety of machinery. It has four cylinders and develops 44 brake horse-power at 1,700 r.p.m.

In this application it is expected that it will be used for driving equipment such as pumps, generators, small saw mills, stone crushers and road-making plant. A clutch having a dry plate of 11 in. in diameter is used, and the lever for controlling the clutch is mounted on the outside of the chassis frame. The output shaft is made from 3 per cent. nickel steel, is fully floating and runs in ball and roller bearings. Two keyways are cut in the shaft, one for a $\frac{7}{16}$-in. rectangular key and the other for a $\frac{7}{16}$-in. taper gibhead key. An electric motor using current from a 12-volt battery of 135 ampere-hour capacity is included in the standard equipment. A control panel is mounted beneath the rear of the engine cowling, and the throttle and other equipment are operated by small hand levers fitted below the panel.

A simple Diesel-engine power pack suitable for driving pumps, generators, small saw-mills, stone crushers, etc.

THE TELEVISION CENTRE

New Building Provides Increased Accommodation

A first stage has been reached in the development of a 13-acre site at Wood Lane, London, W.12, as a Television Centre for the British Broadcasting Corporation. A building, which covers about one acre, has been completed and contains workshops for carpenters, property makers, scenic artists and others engaged in the making of scenery for studio productions. There is also a 26-ft. high setting space in which the scenery can be assembled before it is subsequently transported to the adjacent studios of Lime Grove, as well as 200 offices for the administrative staff, producers and designers.

This scenery block, which is basically a workshop, has been designed by Mr. G. Dawbarn, 5 Gower-street, London, W.1, in association with Mr. M. T. Tudsbery, consulting civil engineer to the British Broadcasting Corporation. Its equipment includes a boiler house, containing oil-fired plant supplied by Rosser and Russell, Limited, 30 Conduit-street, London, W.1. The boiler house can be expanded to serve the whole scheme. To enable large sections of scenery to be moved, an electrically-operated hydraulic lift 30 ft. by 19 ft. by 15 ft. high has been installed by Aldous and Campbell, Limited, 102 Great Dover-street, London, S.E.1, while supplies of electricity for lighting and power are obtained from the public mains through two 500-kVA English Electric transformers. Distribution is effected through sub-switch feed boards, manufactured by Switchgear and Cowans, Limited, Manchester, while an emergency supply for lighting can be obtained from a 110-volt Pritchett and Gold and E.P.S. Company battery. Space has been left for switchgear to feed the main, canteen and workshop blocks, when built, through a high-voltage ring main.

In regard to construction, the basement of the scenery block has been tanked to ground level with reinforced-concrete floors and walls, except in those places where extensions may be made. The earth and water pressures are carried through 12-in. reinforced-concrete panels to buttresses of the same material, which act as propped cantilevers. The superstructure as a whole is a steel frame, the outer stanchions being carried on piers in the basement walls. The suspended floors are of *in situ* reinforced concrete where the loads are heavy, and elsewhere are of "pot" construction. In the scenic artists' studio, which is 65 ft. high from the floor to the roof beams, prestressed pre-cast concrete columns are used and have been designed as cantilevers to resist horizontal wind loads. The roof over this part of the building consists of metal decking, while that over the 26-ft. high setting space is of barrel vault construction. The general contractors for the building were Higgs and Hill, Limited, South Lambeth-road, London, S.W.8. As the building contains cells which exceed the maximum permitted by the London Building Acts, sprinklers and other fire precautions have had to be built in.

The future main studio block will consist of a multi-storey ring built round a garden 150 ft. in diameter, containing accommodation for dressing rooms and offices and space for engineering services as well as the studios. The studios will be enclosed by a continuous run-way along which scenery and other properties can be conveyed. The canteen block, on which work has just been begun, will be used for rehearsals until the main block is occupied. It will be connected with the latter by both a tunnel and a bridge.

Fig. 1 The building on the left is the retort house; on the right, the coke-grading and storing plant. Coal is unloaded by the wagon tipper and taken to the hoppers by conveyors.

NEW CARBONISING PLANT AT STOCKTON

BALANCED-HEATING RETORTS TO PRODUCE TWO MILLION CUB. FT. OF GAS A DAY

On June 22 at Stockton-on-Tees, the Hon. L. W. Joynson-Hicks, M.A., M.P., Parliamentary Secretary to the Ministry of Fuel and Power, performed the ceremony of inaugurating the new carbonising and ancillary plant at the Gas Works. The occasion was marked by the unveiling of a plaque, after visitors had made a tour of inspection of the plant. Mr. E. Crowther, C.B.E., Chairman of the Northern Gas Board, later welcomed the visitors at an official luncheon held at the works.

This ceremony was the latest feature in the development of a Gas Undertaking which originally supplied gas to domestic consumers as early as 1822. The project at that time was under the control of a private company but was acquired by the Stockton Corporation in 1857 and so continued until the nationalisation of the Gas Industry in 1949. The growth of the undertaking under the administration of the Corporation is shown by the increase in annual gas consumption from 116 million cub. ft. in 1875 to nearly 1,400 million cub. ft. in 1949.

In July, 1947, in accordance with plans which had been made for increasing the base load plant, Stockton Corporation Lighting and Power Committee authorised the placing of a contract with West's Gas Improvement Company, Limited, Hulme Hall-lane, Miles Platting, Manchester, 10, for the supply of a complete carbonising installation with a specified daily output of 2,000,000 cub. ft. when carbonising Durham run-of-mine coals, together with foundations for future extensions. This latter step was agreed after numerous ground borings had been taken which revealed sub-strata incapable of sustaining the necessary load until a depth of about 25 ft. was reached; a piled foundation was therefore used.

The decision to increase the daily capacity of the Stockton plant to 4,000,000 cub. ft. was taken by the Northern Gas Board after vesting day (May 1, 1949). It involved, in effect, the transfer of a contract for a 2,000,000-cub. ft. plant for Middlesbrough, also placed with West's Gas Improvement Company, to the Stockton site.

Basically the installation comprises 64 retorts of 50-in./56-in. section, with individual hydraulically-operated sector coke discharge, arranged in two benches of four settings of West's Patent Balanced Heating design, having a nominal capacity of 4,000,000 cub. ft. of gas at 500 B.Th.U.'s per cubic foot. The completed plant is shown in Fig. 1.

COAL HANDLING

Coal is supplied by rail from a siding arranged alongside the retort house. Wagons are discharged by a Mitchell discharge tipper capable of dealing with wagons up to 21 tons capacity at the rate of 12 per hour. The tipper is equipped with an Avery weighing machine with self-indicating and weight-recording apparatus and ticket or tape printing equipment. The contents of the wagons is discharged into a receiving hopper of 21 tons capacity from which it is fed by a reciprocating tray, at a rate controllable up to 80 tons per hour, to the coal breaker and band conveyor. The chutes are so arranged that small coal can be fed direct to the conveyor.

The single-roll coal breaker is of West's standard design capable of reducing 80 tons per hour of Durham coals to sizes not exceeding 2-in. cube. It is driven by a 30-h.p. electric motor through a belt drive with a safety coupling for protection against tramp iron. The speed reduction gear is totally enclosed in an oil bath. From this point the coal is transported by a 30-in. wide troughed band conveyor to either of two lipped-bucket conveyors in the retort house.

The wagon tipper and coal receiving hopper are housed in a steel-framed brick-panelled building with an annexe to accommodate the recording mechanism of the weighing machine. The coal breaker and tray feeder are below ground in a pit covered by steel chequer-plating with access doors, and the band conveyor is in a tunnel covered with reinforced concrete.

Two West lip-bucket conveyors are arranged in the end bay of the retort house, each a complete standby to the other and each capable of handling 80 tons of coal or 35 to 40 tons of coke per hour. They are designed to receive coal from the band conveyor and deliver it to either of two band conveyors over the coal bunkers of the retort bench, or, alternatively, to receive coke from band conveyors below the retort bench and deliver it to the producer and retort feed hoppers or to the coke-screening plant.

The buckets are tipped automatically to discharge their contents at one or more pre-determined points in the horizontal line. Each conveyor is driven by a 24-h.p. electric motor through Radicon speed reduction gear boxes and heavy spur gears.

The coal storage bunkers above the retort benches have a capacity of 60 hours supply for the retorts. They are divided into eight separate compartments, one to each setting of eight retorts, and are lined with blue bricks set in cement. Each compartment is fitted with eight outlets, controlled by a slide door, leading to the gas-tight coal valves of the auxiliary feed hoppers which are in direct communication with the upper end of each retort. The arrangement can be seen clearly in Fig. 2. Coal is transported to the bunkers by two parallel 42-in. wide flat band conveyors. Discharge is by ploughs, the band being automatically supported below the plough, when in operation, by a planished steel plate.

Fig. 2 The coal bunkers discharge into the retorts through the sliding doors and sealing valves which can be seen in this illustration. The gas off-takes are sprayed with liquor.

COKE HANDLING

Coke is discharged periodically (usually every 2 hours) through travelling chutes to two 36-in. troughed band conveyors arranged below the retort house floor. Fig. 3 illustrates this. These transport the coke to either of the two lip-bucket conveyors previously described. From either of these the coke is fed by a 30-in. troughed band conveyor to the coke screening plant. This conveyor is supported in a latticed-steel bridge between the retort house and the bunkers.

The brick and steel bunkers have a capacity of 500 tons of screened coke and are divided into five compartments for the different grades. The screening plant consists of two lines of Pegson vibrating screens. First in each series is a heavy duty scalping screen with a 2-in. mesh. Coke passing over this screen goes either direct to the large coking compartment or to a West-Calvert coke cutter. Coke passing through the screen and coke passing through the cutter is fed to the first grading screen of the line. Outlet chutes from the bunkers are arranged to deliver each grade of coke (with the exception of the breeze) over travelling debreezing screens, one to each side of the bunkers, to railway wagons, to road vehicles or to an Avery automatic weighing and bagging machine. A platform is arranged below this machine for the storage of bags under cover and at a convenient level for the loading of road vehicles. Breeze can be fed either direct to railway wagons or to a 24-in. band conveyor for transport to the breeze elevator and into the breeze compartment of the hoppers.

Producer coke is stored in a hopper in the end bay of the retort house; 18 hours' supply can be stored. This hopper is fitted with an air-tight outlet door leading to a de-dusting screen for delivery to the producer feed skip. The skip is hand propelled on a runway arranged over the producer feeding doors and provided with an Avery automatic weigher and totaliser.

HORIZONTAL COMBUSTION CHAMBERS

In the Glover-West system, the combustion chambers are arranged horizontally across the lines of the retorts, each combustion chamber being provided with its own fuel-gas nostrils, separately controlled, with sight boxes for the inspection of the interior of each chamber. The temperature can, therefore, be readily distributed over the vertical length of the retort to suit the class of coal which is being carbonised; the highest temperature may be in the upper chambers or in the lower, or it may be even over the whole length of the retort.

The " balanced-heating " system was developed to realise a higher thermal efficiency in the carbonising process, and also to provide more effectively for the control of the expansion of the settings. The term " balanced " emphasises the fact that producer gas is admitted to the combustion chambers from both sides of the setting; the products of combustion travelling towards the centre-line. The necessity for supplementary air is thus eliminated and the retorts are heated by the primary combustion.

The secondary-air and the fuel-gas supply ducts are arranged in the outer walls of the setting. The products of combustion pass up the centre of the setting to the circulating chambers where the preliminary heating of the charge is effected. Radiated and conducted heat passing from the centre is thus circulated by the waste gases within the setting rather than being dissipated through the outer walls. The setting is thus self-insulated. Heat is also recovered from the outgoing charge of coke by circulating the secondary air round the bases of the retorts before delivery to the supply ducts.

In the balanced-heating design, the setting is symmetrical about its centre-line. The outer walls are, therefore, of the same weight and thickness, so that horizontal movement due to expansion is equalised about the centre of the setting and reduced to a minimum. These movements are controlled and allowed for by spaces arranged in the walls of the setting and by expansion plates inserted between the walls and the steel members of the retort-bench bracing. This is itself adjustable so that it can be moved outwards to allow for the growth of the refractory materials when restarting. The expansion plates maintain a substantially constant pressure on the brickwork from cold to working temperature. Stable conditions for the operation of the beds are maintained by two Bryan-Donkin governors.

GAS AND COKE EXTRACTION

Hot crude gas from the retort is washed by passing through a continuous spray of liquor from a separating tank placed on the top of the pump house. The pumps for this service are in duplicate and are electrically driven. Each is capable of circulating 13,200 gallons of warm liquor per hour.

Coke extraction from the retorts is of the sector type. The sector extractor cuts off a section of the coke monolith below the base of the retort at regular intervals of 40 to 50 minutes. The sector table is designed to cut the body of the coke along its natural cleavage and it is then transferred to the coke chamber for further cooling before final discharge. When the table returns to the horizontal " at rest " position, the whole charge in the retort drops bodily about 18 in. on to the flat portion of the table. This action has been found to open up free gasways in the newly forming coke at the top of the retort, substantially reducing the amount of manual " rodding " required. The different items can be seen in Fig. 3.

Each sector extractor is hydraulically operated and the sector table can be rotated 56 deg. beyond the tipped position to permit access to the interior of the retort.

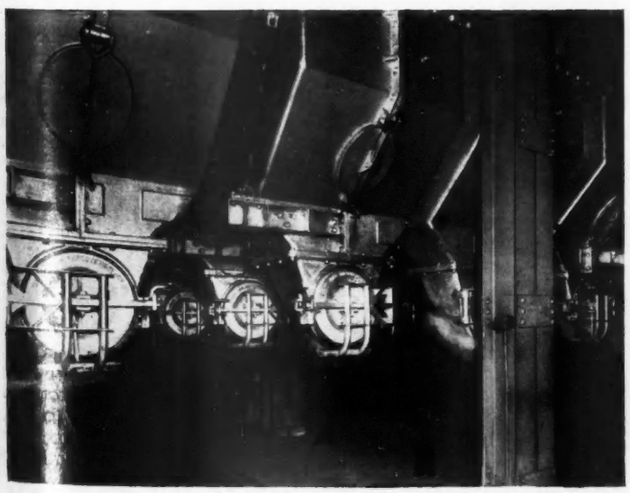


Fig. 3 Coke is removed by sector extractors and directed by travelling chutes on to conveyors. The hydraulic cylinder which operates the sector cutter can be seen between the retorts.

" HOT GAS " PRODUCERS

Fuel gas for the settings is generated in any four of the five mechanical producers which are provided, one being a stand-by.

These " hot gas " producers are designed in conjunction with the retort setting to maintain the thermal efficiency resulting from the retention of the sensible heat in the producer gas. The gas off-take is placed in the centre of the producer so that the hot gas is withdrawn with the minimum contact with the water jacket or outer walls. The upper section of the producer forms a coke storage zone which insulates the gas off-take and ensures a steady gravity feed of coke to the reaction zone, thereby ensuring constant segregation of the fuel sizes. The depth of the ash zone is such as to minimise the disturbance of the fuel bed, and is kept constant by automatic control of the grate speed. The dust extractor is constructed of refractory material and the whole is insulated; producer gas temperatures at the outlet range between 600 and 700 deg. C.

The reaction zone of the producers is surrounded by a water jacket in which sufficient steam is generated at low pressure for their own requirements. The water jacket is enclosed in an air jacket through which the primary air is passed, giving some preheating while retaining easy access to the water jacket.

The two waste-heat boilers are of the Spencer-Bonecourt design, manufactured by Stockton Chemical Engineers and Riley Boilers, Limited, Stockton-on-Tees. Each boiler is capable of dealing with the waste gases from either of the two retort benches and additional steam can be raised by using producer gas. Steam is raised at 225 lb. per square inch superheated to 450 deg. F. with a rated output of 8,200 lb. per hour from each boiler. The induced draught fans are of the Sirocco high-efficiency design with steam-turbine and electric-motor standby drives.

ANCILLARY EQUIPMENT

As a result of the decision to extend the gas-making capacity of the works, it became necessary to reorganise the existing railway sidings and to install some new ancillary equipment. One item is a dry purification plant, consisting of four purifiers 25 ft. by 25 ft. by 10 ft. deep, with oxide-handling plant, which is at present under construction.

Duplicate exhausters of the Holmes-Connersville positive-displacement type have been installed, each being capable of handling 5 million cub. ft. of gas per day against a pressure rise of 68 in. w.g. Each exhauster is driven by a single-cylinder Bellis and Morcom vertical steam engine and the sets are designed to operate on steam at pressures up to 225 lb. per square inch, with 50 deg. of superheat.

Total cooling of the gas is effected in two Whessoe multi-pass vertical water-tube condensers operating in series and located before the exhausters. The advantage of this series arrangement is that if it becomes necessary to by-pass either condenser the other will take the full gas make, with reduced pressure loss, and, by increasing the water flow, a serious rise in outlet gas temperature can be avoided. The cleaning, de-tarring and liquor plants have also been enlarged.

Labour Notes

HUMAN RELATIONS IN MINING INDUSTRY

Pleas were made by Sir Hubert Houldsworth, Q.C., the chairman of the National Coal Board, in a speech at Leeds, on June 21, for better labour relations in the mining industry. If it was desired to obtain the best results from men and managements in the pits, there was no point, Sir Hubert said, in indulging in constant criticisms. The men in the industry were human beings like the rest of the community and frequent complaints did not conduce to an improved understanding of the difficulties that existed.

There had never been a time when the men's leaders were as determined as they were at present to achieve full co-operation with the managerial side of the industry, and full harmony had to exist if the best possible results were to be secured.

If human relations could be improved throughout the industry up to anything approaching the conditions obtaining in the East and West Midlands Divisions, a very much higher tonnage of coal would be mined.

The National Coal Board was planning to obtain an increase in production of 2½ per cent. during the present year and the great task before it was to obtain the best possible relations in all coalfields.

The Board would strive to bring down the price of coal but it should be known more widely that Britain still produced the cheapest coal in Europe and that this country was in a position to undersell producers anywhere on the Continent.

UNION'S PLEA FOR MORE COAL

Support for recent appeals by the National Coal Board, that greater production efforts should be made in British coalfields, is given in the annual report of the executive committee of the National Union of Mineworkers. This is now ready and will be presented to delegates at the union's annual conference at Blackpool next week.

It is admitted in the report that the production aims of the union and the National Coal Board have not been realised. Instead of the 2½ per cent. overall increase in output, which was agreed to by both organisations last January, as forming a reasonable target to set before the industry, production during the 16 weeks following the agreement, rose by only 0·2 per cent.

Even if an additional 100,000 tons of coal were to be mined weekly during the summer period, it is stated, the industry might still be faced, by the end of October, with a deficit of something in the region of one-and-a-half million tons in the total needed to meet end-of-summer stock requirements, export demands, and inland consumption. If production remained at the present level, however, the nation would be faced with a deficit of some three million tons.

Unless there was a considerable improvement in output, the executive committee warns its members, the industry might find itself in a position which it would be in the interests of all concerned to avoid. It would be a tragedy if the industry were faced with the dilemma of either having to cut down coal exports, or of having to import large quantities of coal from abroad.

Any action on those lines, the committee points out, would be detrimental not only to the National Coal Board and the union, but also to the nation as a whole, and both organisations, therefore, must do everything possible to prevent such a situation from developing.

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NOTICES OF MEETINGS

Institution of Mining Engineers

SHEFFIELD
Summer Meeting. Wed., Thurs. and Fri., July 7, 8 and 9. "Recent Research in Mining Subsidence," by C. Beevers and K. Wardell. University of Sheffield, morning session, Wed., July 7. "Machine Mining: Concentration in Space and Time," by A. Scott and W. M. Noble. University of Sheffield, afternoon session, Wed., July 7. Institution dinner, Cutlers' Hall, Sheffield, Thurs., July 8. Various visits and excursions.

Royal Meteorological Society

GODALMING, SURREY
Summer Meeting. National Institute of Oceanography, Wormley, near Godalming, Surrey. Wed., July 7.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

Institution of Mining Engineers, Salisbury House, Finsbury-circus, London, E.C.2. (MONarch 9758.)
Royal Meteorological Society, 49 Cromwell-road, South Kensington, London, S.W.7. (KENsington 0730.)

OVERSEAS ORDERS OF THE NATIONAL COAL BOARD CRITICISED

References to the substantial orders placed in the United States by the National Coal Board, for coal-mining equipment, were made by Mr. R. R. Stokes, M.P., when presiding at the annual general meeting of Ransomes and Rapier Limited, at Ipswich, on June 25.

He said that a new type of walking dragline excavator had been constructed by the company, recently, for installation at the Corby steelworks of Stewarts and Lloyds, Limited. Actually, the firm had not made a great deal out of that machine, but its construction had been a tremendous advertisement, not only for the company, but for the British engineering industry as a whole.

It was disconcerting, therefore, to learn that the National Coal Board had ordered two machines of a similar size from the United States during the present year, and that the cost to the Board would be between 3 and 4 million dollars.

Mr. Stokes said that the Board would have liked to order from Ransomes and Rapier, but it could not wait for delivery. This was due to its having planned extensive underground mining operations, but having made no such arrangements for opencast mining, on which machines of the kind referred to would be required.

It did seem to be a severe criticism of the Government departments concerned that they could not enter into mutual consultation and plan sufficiently far ahead to enable them to purchase large-scale machinery of that character from firms in Britain.

RAILWAY LODGING-TURNS DISPUTE

Discussions were due to be opened last Wednesday, between representatives of the British Transport Commission and the two unions representing railway enginemen, on the request of the Associated Society of Locomotive Engineers and Firemen that all turns of duty involving train crews having to spend a night away from their homes should be abolished. Both the A.S.L.E.F. and the National Union of Railwaymen, the other union concerned, are anxious that lodging turns should be permanently abandoned.

Demands for strenuous efforts to bring this about were made at a meeting of the unofficial "all-line action committee" at York on June 21. The committee claims to represent enginemen employed at depots on the Eastern and North Eastern Regions of British Railways, but it is not recognised by the unions.

After some discussion, the delegates passed a resolution stating that the conference, having considered the decisions of the depots, to await the outcome of official negotiations on double home working turns, had decided to urge all branches of the unions to work vigorously for the total abolition of these turns. It was also decided that the committee should be recalled to consider further action should the official negotiations "prove unduly protracted."

Meetings of locomotive men at the depots, prior to June 21, had rejected recommendations for an all-out strike, and for token strikes on Sundays, as means of protesting against the continuation of lodging turns.

PAY INCREASES FOR ENGINEERING CLERICAL STAFFS

Some 200,000 clerical employees in the engineering group of industries are to receive increases in their salaries, as a result of further negotiations between the unions concerned and the Engineering and Allied Employers' National Federation.

According to an announcement on June 21, the increases will range from 7*s.* a week more for adult women to 10*s.* 6*d.* a week extra for adult men, and there will be proportionate advances for juveniles.

The new basic rates for men will be £6 15*s.* 6*d.* a week, at the ages of 21 and 22, rising to £6 17*s.* 6*d.* a week, at 25 years of age and above. Women aged 21 years and over will receive £5 1*s.* 0*d.* a week in future.

These increases are in line with those granted on June 16 to engineering draughtsmen, and, as in their case, the higher salaries will be antedated to May 10, last.

EXTENSIVE WAGE INCREASES IN MAY

Changes in the rates of wages which came into operation in the United Kingdom during May last, resulted in an aggregate increase that was estimated by the Ministry of Labour and National Service to amount to £481,000 a week net in the full-time wages of 1,909,000 workpeople.

The principal increases during the month affected persons employed in the building trades, the civil-engineering contracting industry, and the iron and steel industry. Others receiving increases included employees in the electricity-supply, paper-box making, heating and ventilating, domestic-engineering, cement-manufacturing, and gas industries.

In the building and civil-engineering contracting industries, there was an increase of 1½*d.* an hour for adult men, and, in the iron and steel industry, small increases were granted under sliding-scale agreements based on advances in the level of the interim index of retail prices.

According to particulars in the *Ministry of Labour Gazette* for June, there was an increase of 1½*d.* an hour in the standard scheduled rates for adult male operatives in the gas industry. Works maintenance craftsmen in that industry received an increase of 2½*d.* an hour. In the heating and ventilating and domestic-engineering industries, there was an increase of 1½*d.* an hour for craftsmen and adult mates. Adult men in the cement-manufacturing industry, other than maintenance craftsmen and transport staffs, received an increase of 1¾*d.* an hour.

Some £335,000 of the total increase of £481,000 for the month, resulted from arrangements made by Joint Industrial Councils, or other joint standing bodies, formed by voluntary agreement.

During the five months from January to May, 1954, some 6,543,500 persons received increases in their normal full-time wages amounting to £2,135,800 a week net.